Government of Alberta
Sustainable Resource Development

Best Management Practices User Manual For Aggregate Operators On Public Land

Version 1

Disclaimer

The *"Best Management Practices User Manual for Aggregate Operators on Public Land"* is written to guide operators in the planning, development, operation and reclamation of their pit or quarry which is operating on public land. As such, that person assumes full responsibility for any consequences arising from the use of this manual.

While every effort has been made to ensure the accuracy of the information provided within this manual, users should use their best judgement when applying any practices described in this manual. Alberta Sustainable Resources Development (ASRD), all levels of government represented in this manual as well as any organization or company that have contributed to the development of this manual assume no liability or responsibility for any consequences that may arise through the use of this manual.

All items within this manual are 'general considerations' applied on a broad scale, and may not be applicable in your local area or for a specific location. Operators should contact their local ASRD office for further details and clarifications. All sites should be evaluated and considered for specific details related to their location on the landscape including knowledge of local concerns or priorities.

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Acknowledgements

The *"Best Management Practices User Manual for Aggregate Operators on Public Land"* was written to support the "Guideline for Acquiring Surface Material Dispositions on Public Land" by providing examples of best management practices that can be included in the development of the Conservation and Reclamation Business Plan, required in the application for a Surface Materials Lease. The Information presented in this document was based on the following government documents:

- *Guidelines for Acquiring Surface Material Dispositions on Public Land.* Alberta Sustainable Resource Development, 2007.
- *Guide to the Code of Practice for Pits.* Alberta Environment, 2004.
- *Design Guidelines for Erosion and Sediment Control for Highways.* Alberta Transportation, 2003.
- *Environmental Management Systems Manual* (v.5). Alberta Transportation, 2008.

Erosion and sediment control drawings were provided by:

- *Bio Draw 2.0.* J.A. McCullah, 2000.
- The final draft was developed with input from individuals from the following:
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- Alberta Transportation.

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1 Introduction

Alberta is known around the world for its natural beauty, diversity of ecosystems and its rich natural resources. The mandate of Alberta Sustainable Resource Development (ASRD) is to encourage balanced and responsible use of Alberta's natural resources through the application of leading practices in management, science, and stewardship.

To achieve this mandate ASRD develops legislation, and policy, regulations, guidelines and best management practices (BMPs) for a variety of industries and activities. Such documents are based on available science and user experience and are developed in a manner that encourages stewardship of Alberta's natural resources. This manual provides examples of BMPs that can be applied during the operation of a pit or quarry on public land.

Surface materials (sand, gravel, clay, marl) have served a vital role in economic growth and development through the construction of new roads, schools, hospitals, houses and businesses. These materials are also key to the development of other resources such as steel, glass, paper, pharmaceuticals, cement, insulation and fertilizers to name a few. As producers and consumers, the Aggregate Industry contributes to the growth of Alberta's Oil and Gas, Construction, and Environmental industries. Aggregates will continue to be an important resource as population growth and infrastructure demands increase across the province.

The demand for surface material (hereby referred to as aggregate) extraction on public land has increased significantly in recent years and allocation has become more complex as users compete for limited resources. Statistics Canada reported an estimated 48,430,000 tonnes of sand and gravel production worth $370 million in Alberta and $1 275 billion across Canada in 2006[1]. In response to the increased demand for the resource, ASRD developed the "*Alberta Aggregate (Sand and Gravel) Allocations Policy for Commercial Use on Public Land*[2]" in 2006. In 2007, an operational guideline, "*Guideline for Acquiring Surface Material Dispositions on Public Land*[3]" was completed to supplement the new *Aggregate Policy*.

The extraction of aggregate resources on public land should not leave an environmental burden for future generations to remedy. To ensure the responsible extraction of this resource, ASRD has identified a need to provide further clarity for operators on BMPs for site development, planning, management and reclaiming sand and gravel pits and quarries. The adoption of a combination of appropriate BMPs can help ensure that aggregate extraction does not affect the long-term environmental sustainability of public land.

[1] Statistics Canada 2006
[2] ASRD 2006
[3] ASRD 2007

In this manual, you will find information on:

- The regulatory framework required for extracting aggregates on public land; and
- BMPs for managing environmental considerations during the planning, development, management and reclamation phases of an aggregate operation.

This manual applies to the mining of aggregate on public land and addresses the primary processing of aggregate only. While some BMPs may also apply, this manual does not address pits located on private land or the mining of peat on public land. For more information about mining peat or aggregate extraction on public land, contact the ASRD Edmonton Office at:

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2 How To Use This Manual

2.1 Purpose of the Manual

The "*Best Management Practices User Manual for Aggregate Operators on Public Land*" (this document) was developed to provide Aggregate Operators with a wide selection of best management practices (BMPs) for mitigating environmental concerns associated with an aggregate operation on public land. The BMPs presented in this manual are examples of easily available practices that will help minimize any potential effects to the surrounding land, surface water and air. This manual covers BMPs applicable to planning and developing a site through to the reclamation phase of a project.

The BMPs presented in this manual are some of the most effective techniques for mitigating environmental concerns during an aggregate operation; however, it is not a comprehensive document. Other techniques may exist that may be as effective on a site and, where applicable, they should be applied. The BMPs are not Codes of Practice, regulations or laws, but guidelines; they are practices that have been proven effective and in many cases economical when implemented in aggregate operations across North America.

Aggregate Operators who are seeking permission to extract aggregate from public land are encouraged to use this manual for selecting mitigation techniques when developing a Conservation and Business Reclamation Business Plan (CRBP; see section 3.1). It is the responsibility of the applicant to determine which BMP's are most suitable for their proposed operation. Operators should contact their local ASRD office for further details and clarifications regarding the development of site-specific plans. All sites should be evaluated on an individual basis and operators should consider site specific details related to their location on the landscape, including knowledge of local concerns or when selecting BMP's.

2.2 Description

The following manual provides examples of BMPs for mitigating environmental concerns when working on public land. The manual is broken down into the following sections:

Section 3.0 provides background information on the permitting framework for obtaining approvals to extract aggregate on public land;

Section 4.0 describes regulatory framework that applied to an aggregate operation on public land;

Section 5.0 describes possible end land-uses for reclaiming aggregate pits on public land;

Section 6.0 provides examples of BMPs, used across North America, which have been utilized as effective environmental management practices; and

Section 7.0 describes BMP monitoring throughout the life of an aggregate operation.

Government contact information is provided in **Appendix A**. Factsheets are provided in **Appendix B**; the factsheets provide further details about the implementation of specific BMPs presented in this document. **Appendix C** provides a list of current, available literature regarding aggregate extraction and environmental mitigation.

3 Alberta Aggregate Permitting Framework

3.1 Public Lands Act (ASRD)

The *Public Lands Act* applies to public land that is owned by the Crown in right of Alberta and is administered by ASRD. The *Public Lands Act* authorizes and regulates the allocation and use of public land. This includes the beds and shores of all permanent and naturally occurring bodies of water and all naturally occurring rivers, streams, watercourses and lakes[4]. It is the main provincial statute governing surface material extraction in the province of Alberta. It also applies to pits that are located within, or affect, the bed and shore of a water body or watercourse.

The *Disposition and Fees Regulation* included in the *Public Lands Act* grants approvals through an application, lease and licensing system. It is important that applicants become familiar with the application process before they apply. It is in the applicant's best interest, to become familiar with the regulations as the application process and land management responsibilities can involve a significant investment of time and resources. Increased knowledge of the application process will also help aggregate operators prepare for the future development of their operation. It is important to understand the process for a disposition application, as more complex applications require longer review, processing and referral periods. As well, an incomplete application may result in approval delays, requiring revision and re-submission by the applicant.

Approvals through the *Public Lands Act* are granted for the following:

- Surface Material Lease (SML) – Granted for up to 10 years these are designed for long-term use to extract large quantities of aggregate on large tracts of land (pits up to 80 acres in size on individual applications, and over 80 acres pending the "bonus bid" or public advertising process).
- For an SML, a Surface Material Exploration (SME) program must be conducted to define where the aggregate is present.
- The application for an SML requires a detailed Conservation and Reclamation Business Plan (CRBP), which describes how the applicant proposes to develop the aggregate resource, manage environmental and/or land-use issues, and integrate the operation with other land interests while meeting legislative requirements.

What is a Conservation and Reclamation Business Plan?

A Conservation and Reclamation Business Plan (CRPB) is a detailed plan describing how an applicant proposes to develop the aggregate resources and resolve any environmental and/or land-use issues. The CRBP must provide the following:

1. A brief description of the project and market conditions;
2. A description of the aggregate resource and proposed operation;
3. Potential regulatory requirements triggered by the project;
4. Analysis of biophysical and land-use conditions at the proposed site and mitigation measures; and
5. Sequential plans for site development, operation and reclamation of the pit.

The BMPs presented in this manual can be incorporated into the CRPB where applicable. It is the responsibility of the applicant to determine which BMP's are most suitable for their proposed operation.

[4] Alberta Transportation 2008

- Applicants must identify other potential stakeholders ensuring that any potential land use conflicts are identified and resolved. These may include access restrictions, timber licences, trapping licences or grazing leases as examples.
- Surface Material Licence (SMC) – These are designed for short-term use (up to a maximum of one year) on small parcels of land (maximum area is 5 acres or 2 ha) for a specific volume of material.
- The SMC must be supported by an SMC aggregate field report.
- Public Pit Licence (PPL) – These are typically issued for extraction from government held extraction sites and are designed for quick removal (valid for only one year) of a limited amount of material.
- In some cases a pit manager may be selected through a Request for Proposal (RFP) process and will be responsible for operating the pit and making aggregate available to other operators.
- A licence can be issued immediately at any ASRD office.

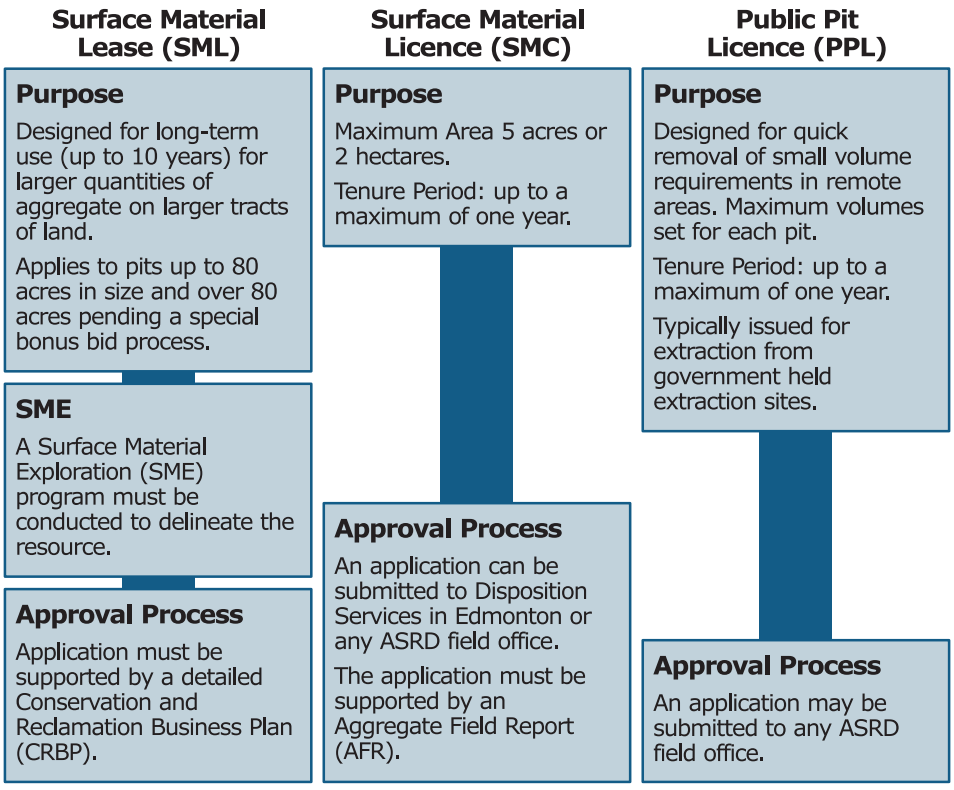

Surface Material Lease (SML)
Purpose
Designed for long-term use (up to 10 years) for larger quantities of aggregate on larger tracts of land.
Applies to pits up to 80 acres in size and over 80 acres pending a special bonus bid process.
SME
A Surface Material Exploration (SME) program must be conducted to delineate the resource.
Approval Process
Application must be supported by a detailed Conservation and Reclamation Business Plan (CRBP).
Surface Material Licence (SMC)
Purpose
Maximum Area 5 acres or 2 hectares.
Tenure Period: up to a maximum of one year.
Approval Process
An application can be submitted to Disposition Services in Edmonton or any ASRD field office.
The application must be supported by an Aggregate Field Report (AFR).
Public Pit Licence (PPL)
Purpose
Designed for quick removal of small volume requirements in remote areas. Maximum volumes set for each pit.
Tenure Period: up to a maximum of one year.
Typically issued for extraction from government held extraction sites.
Approval Process
An application may be submitted to any ASRD field office.

Figure 1: Common dispositions - surface material extraction on public land.

When seeking an approval to operate an aggregate pit on public land the following regulations apply:

1. Operators require a Surface Material Licence (SMC) or Lease (SML) under the Public Lands Act, regardless of the size of the pit. The operation of the pit is subject to any terms or conditions described in the licence or lease.
2. All activities are subject to enforcement under the Public Lands Act and the Environmental Protection and Enhancement Act and are subject to the Environmental Protection Guidelines.
3. All pits require a Reclamation Certificate. Reclamation Certificates are obtained from ASRD. The liability of an SML is effective until the disposition holder has obtained their certificate.
4. Pits on private or public land may require an approval under the Water Resources Act if water is used (e.g., for gravel washing) or diverted (e.g., for pit dewatering) or if the pit is within the floodplain of a watercourse or waterbody.

Source: Alberta Environment 1996.

A detailed description of these common dispositions is available in the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[5]". Application forms for an SML and SMC can be found on the ASRD webpage under the maps and forms section (Lands Forms):

http://srd.alberta.ca/MapsFormsPublications/Forms/LandsForms/Default.aspx

It should be noted that an approval under the *Public Lands Act* does not guarantee the right to extract or operate, as other legislation may apply and further additional approvals or authorizations under other regulations may be required. A disposition issuance, unless otherwise stated, *does not* provide the holder permission rights to any other resource extraction or altered use of the land such as (but not limited to): removal of timber, water, soil, or vegetation, unless specifically stated. The use of the land is only for the purpose of extraction of the gravel resource and is subject to any terms or conditions described in the SML as defined within the parameters of the department approved CRBP or as temporarily approved or amended under the issuance of a Temporary Field Authorization (TFA) including applicable laws and regulations governing the province of Alberta. Anything outside of these activities requires additional approvals and should not occur on public land without them.

Operators should be aware of the following list of federal and provincial departments and the corresponding *Acts* that may also require contact and/or consultation in obtaining appropriate permits, licenses, etc. when undertaking aggregate operations on public land. While this list is provided to further assist the applicant; it should not be considered comprehensive and is subject to changes in legislation and regulations. It is the responsibility of the applicant/operator to ensure all relevant approvals and authorities are obtained prior to commencing operations.

A key regulatory approval BMP is to meet with your local SRD representative at an early stage of the process to clarify the regulatory process for each individual operation.

[5] ASRD 2007

It is the responsibility of the operator to know and understand the environmental considerations associated with an aggregate operation.

1. Understand the natural environment at the proposed locations;
2. Recognize potential effects of the operation on fish and wildlife habitat, fish and wildlife populations, water quality and quantity, and long-term impacts to the surrounding landscape;
3. Recognize and address the need to avoid, mitigate or lessen any effects;
4. Understand the federal, provincial and municipal legislated requirements for conducting the operations; and
5. Conduct the operation in a manner that complies with the law and avoid, mitigates, or reduces potential effects to the environment.

Source: BC Standards and Best Practices for Instream Works, 2004

4 Alberta Aggregate Regulatory Framework

The environmental obligations for an applicant seeking to operate a pit or quarry on public lands are guided by legislation enacted by both the federal and provincial governments. Many Canadian federal and provincial *Acts* and regulations, as well as municipal bylaws, include provisions designed to ensure public lands are developed within accepted practices providing for environmental mitigation. The summary presented here outlines some of the more common federal and provincial *Acts* and regulations that an operator may encounter during the permitting and operation of their site. Both the permitting and regulatory framework can change over time. An awareness of current legislation and requirements is essential for ensuring that the work is in compliance with all applicable *Acts*, regulations and bylaws.

4.1 Federal Requirements

Several federal departments enforce *Acts* that will dictate the actions that can be undertaken by aggregate operators on public lands. Key federal *Acts* include: the *Fisheries Act*, and the *Migratory Birds Convention Act*, which are described in section 4.1.1 and 4.1.2. Operators may also need to consider the *Species at Risk Act*, which provides protection for threatened and endangered species, the *Navigable Waters Protection Act* (NWPA), which ensures Canadians the right to passage on Canadian waterways, and the *Canadian Environmental Assessment Act* (CEAA), which applies when an NWPA approval or *Fisheries Act* approval Authorization is required or if federal funding is provided on the project. CEAA can also apply when gravel pits are operating to support the construction of all-season public highways greater than 50 km in length. Key federal regulatory requirements that may apply to an aggregate operation on public lands are described in Table 1. Government contact information is presented in Appendix A.

Table 1: Federal regulatory requirements that may apply on public land.

Act	Responsible Agency	Description
Fisheries Act	Fisheries & Oceans Canada	Protects fish and their habitat across Canada.
Fisheries Act (Section 36(3))	Environment Canada	Prevents the deposition of deleterious substances into fish bearing waters.
Migratory Bird Convention Act	Canadian Wildlife Service	Protects migratory birds, their eggs and their nests from harmful activities.
Species at Risk Act	Environment Canada	Provides protection for the recovery of threatened and endangered species and encourages the management of all other species to prevent them from becoming at risk.
Navigable Waters Protection Act	Transport Canada	Protects the publics' right to navigation in all navigable waters.
Canadian Environmental Assessment Act	Environment Canada	Requires any federal department to conduct environmental assessments for prescribed projects and activities before providing federal approval or financial support.

4.1.1 The Fisheries Act

The *Fisheries Act*, administered by the Department of Fisheries and Oceans (DFO), prevents the harmful alteration, disruption or destruction of fish and fish habitat. It is binding on federal, provincial and territorial governments. The Act regulates the protection of fish habitat, pollution prevention, the harvesting of fish, and the safe use of fish. Key provisions of the Act include:

- **Section 30** requires that water intakes and conveyance structures are equipped with guards or screens to exclude fish, and allows DFO to specify screen size and maintenance requirements. Section 32 is a general prohibition against destroying fish by any means other than fishing except as authorized by the Minister or under regulations. This could apply to the use of explosives near water, dewatering activities, or any other means by which fish may be destroyed.
- **Section 35 (1)** prohibits any *harmful alteration, disruption or destruction of fish habitat* (HADD). Simply stated, this means that an operator cannot do anything to harm fish habitat. It applies to all fish habitat in Canada.
- **Section 35 (2)** establishes that a HADD can occur without violating Section 35 (1) if the works are authorized by the Minister of DFO. An important distinction is that a HADD authorization authorizes the HADD only, not the project[6].
- **Section 36 (3)** prevents the deposition of deleterious substances. Environment Canada is the lead agency on enforcement of Section 36 (3); however, ultimate authority lies with DFO. Aggregate operations may require approvals for actions such as road crossings through streams, or activities that will affect the streambank. Common substances are silt (Figure 2), fertilizers, hazardous materials, pesticides, or any other chemical or biological agent that may harm fish.

Operators should consult DFO to determine if an authorization is required (Appendix A).

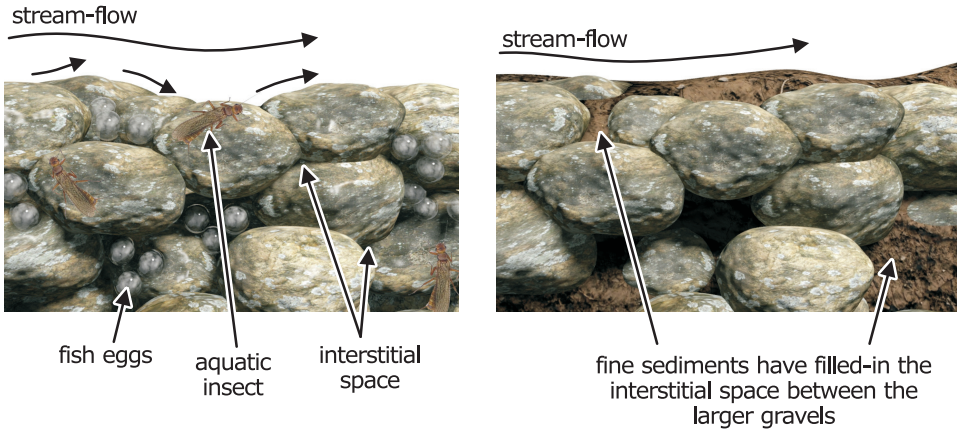


Figure 2. Sediment can smother eggs and prevent streamflow from moving through streambed material (adapted from: BC Ministry of Land and Water, 2004).

[5] Transportation Association of Canada 2005

4.1.2 Migratory Birds Convention Act

The *Migratory Birds Convention Act*, administered by the Canadian Wildlife Service, protects migratory birds, their eggs and their nests from harmful activities. The *Migratory Birds Convention Act* will apply throughout all stages of an aggregate operation but may be most applicable during construction, as it is considered an offence to "disturb, destroy or take a nest, egg, or nest shelter" of any migratory bird (nesting period is generally early April to late August in most parts of Canada). Through this *Act*, efforts are made to protect any site that has nesting birds, including riparian areas, uplands and wetlands. In addition, the Act also prevents a person from depositing oil or any other harmful substance into waters or any area frequented by migratory birds.

Permits may be authorized for the following activities: migratory game bird hunting, scientific activities, avicultural activities, airport collisions, taxidermy, eiderdown and other special activities. There are no permits authorized for disturbing, destroying or taking a nest, egg, or nest shelter of a migratory bird except for scientific purposes. This legislation strictly prohibits these activities.

Contact the Canadian Wildlife Service (Appendix A) to determine which requirements apply to an aggregate operation.

4.2 Provincial Requirements

The Province of Alberta has legislation in place to ensure the long-term viability of Alberta's environmental interests. Several provincial departments enforce legislation that will dictate the actions that can be undertaken by aggregate operations on public land. A list of frequently applicable provincial legislation is provided in Table 2. Some of the more commonly used legislative requirements are discussed in sections 4.2.1 through 4.2.6. Aggregate Operators should be familiar with all legislation which may be applicable to their operation. Government contact information is provided in Appendix A.

Table 2: Primary provincial legislative requirements that may be applicable to an aggregate operation on public land.

Act	Responsible Agency	Description
Public Lands Act	ASRD	Requires approvals for activities taking place on public land under the administration of the Minister of ASRD, as well as the beds and shores of all naturally occurring rivers, streams, watercourses and lakes, under the administration of the Minister of ASRD. The *Disposition and Fees Regulation* grants approvals to extract aggregate on public land.
Water Act	AENV	Regulates the allocation, protection and conservation of water within Alberta. The "*Code of Practice for Watercourse Crossings*" directs all watercourse crossings and requires that notice be submitted to the Minister prior to conducting any instream works.
Wildlife Act	ASRD	Prohibits the disturbance of wildlife habitation. The *Wildlife Regulation* identifies the wildlife, areas and times of year to which the Act applies.
Forests Act	ASRD	Requires approval for any forest management activity (e.g. timber harvest) which occurs on public land.
Environmental Protection and Enhancement Act	AENV	Requires a review of proposed projects that may cause an adverse effect on the environment, and the reclamation and conservation of land. Key regulations that may apply to the operation of pits on private land include: *Conservation and Reclamation Regulations* and the *Pesticide Regulation*. The "*Code of Practice for Pits*" falls under the Conservation and Reclamation Regulation. It applies to all pits on private land greater than 5 hectares.
Soil Conservation Act	Alberta Agriculture and Rural Development	Requires that landholders (the occupant or owner of the land) take appropriate measures to prevent soil loss or deterioration or, if it is occurring, stop the loss or deterioration from occurring on their land.
Weed Control Act	Alberta Agriculture and Rural Development	Governs the legislation of restricted, noxious and nuisance invasive plant species or weeds.
Alberta Land Stewardship Act	ASRD	Regional plans will consider the combined impact of all activities on the land, air, water and biodiversity, and will be developed with advice from Albertans.
Mines and Minerals Act	ASRD and Alberta Energy	Governs the management and disposition of rights in Crown owned mines and minerals, including the levying and collecting of bonuses, rentals and royalties.
Historical Resources Act	Alberta Culture and Community Spirit	Purpose is to preserve, protect, and present historical and archaeological resources of provincial, national and international significance.
ERCB D-50 Directive – Water Pump Off	ASRD	Requires that a Temporary Field Authorization be issued prior to pumping pit water onto public land. Toxicology testing may be required prior to obtaining a permit.

4.2.1 Environmental Protection and Enhancement Act

The *Environmental Protection and Enhancement Act* (EPEA) was developed to promote and support the protection, enhancement and wise use of the environment. This *Act* is the key piece of environmental protection in Alberta.

Section 60 and 61 prohibit anyone from commencing or continuing an activity designated by the regulations as requiring an approval or registration unless they hold the required approval or registration. Pits less than 5 ha and pits on public land do not require an EPEA approval; however, pits on public land would require an SML or an SMC under the *Public Lands Act* (Section 3.1).

Sub-Sections 108 and 109 of the *Act* protect against the knowing release or permit the release of a substance into the environment in an amount or at a rate of release that is in excess of an approval or a regulation; or may cause a significant adverse effect.

A substance can include any matter that is capable of becoming dispersed into the environment, including soil particles from construction activities, particulate emission, chemicals, or other airborne material. It is the duty of the person undertaking the construction to provide remedial activities through repairing or confining the source when a substance is released into the environment that has caused, is causing, or may cause an adverse effect. The situation must be rectified to the satisfaction of Alberta Environment.

If a release does occur it must be reported in person or by telephone 780.427.2700 to Alberta Environment and be followed up by a written report submitted within 7 days of the verbal report.

Part 6 of the EPEA deals with the conservation and reclamation of land. Under **Section 137** of EPEA, an Aggregate Operator is required to conserve and reclaim specified land and obtain a reclamation certificate[7]. This includes pit operations. Reclamation certificates for pits on public land are issued by ASRD. The reclamation certification process is described in the *Conservation and Reclamation Regulation*.

[7] The operator remains liable for all conservation and reclamation issues until they receive a Reclamation Certificate

4.2.2 Water Act

The *Water Act* is applicable when a shoreline, surface water and/or groundwater resource may be affected. Operations on public land have the potential to affect these resources both onsite (directly) and offsite (indirectly) which may affect adjacent land and water users. For example, the *Water Act* may apply to your operation if:

- water is diverted or removed from the site,
- water is retained, collected, or the pit location falls within a floodplain;
- structures are being proposed for construction on bed and shore for streams, lakes or rivers; or
- the operation may potentially affect a stream or wetland.

Sections 36(2) and 49(1) of the *Act* prohibit anyone from carrying out an activity, diversion of water or operation of a works that are subject to a Code of Practice unless notice is provided to the director in accordance with the regulations. This includes the *Code of Practice for Watercourse Crossings* which will apply if watercourse crossings are required for site access[8].

In addition, a *Water Act* approval may be required if a surface waterbody (such as a lake or pond) is planned as a final reclamation objective end land-use. With a few exceptions, beds and shores of all permanent and naturally occurring bodies of water as well as all naturally occurring rivers, streams, watercourses and lakes are managed by the Crown under the *Public Lands Act*[9]. Requirements under the *Public Lands Act* are described in Section 3.1. Operators are encouraged to contact their local ASRD Land Office as well as notify Alberta Environment for more information about requirements and exemptions.

4.2.3 Wildlife Act

The *Wildlife Act* protects wildlife and their habitat across Alberta. Under **Section 36** of the *Wildlife Act*, the disturbance of wildlife habitat is prohibited. A person must not molest, disturb or destroy a house, nest or den of any wildlife listed in Section 4 of the *Wildlife Act – Wildlife Regulation* or a beaver dam in prescribed areas and at prescribed times, unless the person is permitted to do so under the *Agricultural Pests Act* or the *Water Act*, a licence authorizing the control of wildlife depredation or the collection of wildlife, or regulations under the *Act*.

Section 96 of the *Wildlife Act – Wildlife Regulation* defines the wildlife, areas and time of year to which Section 36 of the *Act* applies. Included are all endangered wildlife, upland game birds, some migratory birds, snakes, bats and beavers. For most of the wildlife species included in the regulation, disturbing the habitat is prohibited across Alberta and for the

[8] Alberta Transportation 2008

[9] Alberta Transportation 2008

most part of the year. Operators are encouraged to work with ASRD to determine how this *Act* will influence the operation of their pit.

4.2.3.1 Rare Species

Rare species are native species that exist in low numbers or in very restricted areas. Rare plant species and rare plant communities in Alberta are listed in the Alberta Natural Heritage Information Centre (ANHIC) tracking list[10]. The Alberta Natural Heritage Information Centre (ANHIC) can be contacted to determine if any rare species have been detected within the proposed project area (Appendix A). ASRD may require a wildlife inventory to be completed prior to the issuance of a disposition. Contacting ASRD prior to submitting an application will help identify these requirements early in the application process. Wildlife inventories for species at risk concerns are regularly a requirement in Southern Alberta.

4.2.4 Weed Control Act

Within the Province of Alberta, the *Weed Control Act* governs the legislation of restricted, noxious and nuisance invasive plant species or weeds. Restricted weeds tend to be limited in distribution and abundance, typically have not yet become established in the province, and are required to be destroyed in order to prevent establishment. Noxious weeds are more prevalent and are well-established in the province, and as such, require control measures where found.

Section 31 of the *Act*, requires the occupant or owner of the land to destroy all restricted weeds and control all noxious and nuisance weeds to prevent the spread, growth, ripening or scattering of the weeds. A list of restricted and noxious weeds is found in Table 3.

Section 35 of the *Act* prohibits the movement of machines or vehicles that, if moved, would likely cause the spread of restricted, noxious or nuisance weeds.

Under the current *Act* there are seven restricted weed species and 23 noxious weed species (Table 3), as well as an additional 36 weed species classified as nuisance species. Municipalities and Counties within the Province of Alberta may also upgrade the status of certain weeds from nuisance to noxious and from noxious to restricted, depending on the areas' specific weed issues. Updates may be provided on the Municipality's website. Local weed inspectors may be contacted for more information.

[10] ANHIC 2000

Cleavers
(Galium purium)

Common Tansy
(Tanacetum vulgare)

Leafy Spurge
(Euphorbia esula)

Oxeye Daisy
(Chrysanthemum leucanthemum)

Sow Thistle
(Sonchus arvensis)

Table 3: Alberta Listed Restricted and Noxious Weed Species.

	Common Name	Scientific Name
Restricted	red bartsia	*Centaurea serotina*
	diffuse knapweed	*Centaurea diffusa*
	spotted knapweed	*Centaurea maculosa*
	nodding thistle	*Carduus nutans*
	Eurasian water milfoil	*Myriophyllum spicatum*
	dodder	*Cuscuta spp.*
	yellow star thistle	*Centaurea solstitialis*
Noxious	Russian knapweed	*Centaurea repens*
	filed bindweed	*Convolvulus arevensis*
	white cockle	*Lychnis alba*
	bladder campion	*Silene cucubalus*
	false cleavers	*Galium aparine*
	cleavers	*Galium spurium*
	hoary cress	*Cardaria spp.*
	knawel	*Scleranthus annuus*
	perennial sow-thistle	*Sonchus arvensis*
	cypress spurge	*Euphorbia esula*
	stork's bill	*Erodium cicutarium*
	creeping thistle	*Cirsium arvense*
	toadflax	*Linaria vulgaris*
	Persian darnel	*Lolium persicum*
	scentless chamomile	*Matricaria maritima*
	common tansy	*Tanacetum vulgare*
	blueweed	*Echium vulgare*
	spreading dogbane	*Apocynum androsaemifolium*
	field scabious	*Knautia arvensis*
	hound's tongue	*Cynoglossum officinale*
	oxeye daisy	*Chrysanthemum leucanthemum*
	tall buttercup	*Ranunculus acris*
	purple loostrife	*Lythrum salicaria*

Nuisance weeds are also defined under the *Weed Act*. These species can be found throughout the province and, once introduced to a site, can be very difficult to eliminate. These species as well as a many other non-native species can create problems for local ecosystems. For this reason, it is very important to prevent the introduction of any non-native species at a site.

4.2.5 Historical Resources Act

Historical Resources Act clearances may be required for proposed aggregate operations if the parcel of land is listed in the *Listing of Significant Historical Sites and Areas* and/or potential artefacts have been observed on the land.

Applications for clearance under the *Historical Resources Act* must be submitted to the Heritage Resources Management Branch of Alberta Culture and Community Spirit. Site work must be conducted by qualified professionals.

4.2.6 Municipal Requirements

Municipal requirements, such as those identified under zoning and land-use bylaws, must be determined and subsequent municipal authority obtained. Municipalities may require the operator to obtain and hold a current valid Municipal Development and/or a Municipal Business License to conduct operations within its' municipal boundaries. Municipal land-use and zoning plans will identify any potential municipal development limitations such as hours of operation, buffers, noise, dust, haul routes, and traffic control. Permit applications are reviewed by the local municipal planning commission under the authority of the *Municipal Government Act*. Operations must be an approved activity within municipal zoning and the current municipal land-use plans. Municipal bylaws may also provide provisions intended to manage public safety, material transportation, stormwater management, public safety public notification, etc. The specified number of municipal regulatory requirements applicable to a project must be reviewed and determined on a project by project basis. The local municipality should be contacted for further information and details.

4.2.7 Multiple Use

The issuance of a disposition to extract aggregate from public land is just that. A SML disposition issuance, unless otherwise stated, does not provide the holder permission or rights to any other resource extraction or altered use of the land. Further, it is the responsibility of the disposition holder to determine if other dispositions exist for the area and obtain written consent from the other disposition holder that may be affected by the lease. These may include Forestry Management Agreement (FMA)

holders, Commercial Timber Permits (CTP) holders, Grazing Leases (GRLs) and Fur Management Licences (FMLs). Current and final land-uses must be discussed with the disposition holder to ensure that they concur with the plans.

4.2.8 Continuous Improvement

It is the expectation of the Alberta Government that operations on public land, and industry as a whole, will continuously review operating practices and equipment with the purpose of improving environmental performance[11]. Areas of focus for continuous improvement include:

- Minimizing the footprint of the development by applying BMPs;
- Minimizing disturbance to sensitive environments through the use of buffers and setbacks;
- Minimizing disturbance to onsite vegetation by only clearing the areas necessary for construction;
- Maximizing resource extraction and utilization through good project planning;
- Minimizing water use through recycling water and proper planning;
- Reducing dust, noise and contamination to land and water;
- Improving effectiveness of soil handling equipment and processes;
- Maintaining the quality of topsoil through proper stockpiling techniques;
- Maximizing direct placement of topsoil;
- Maximizing speed of progressive reclamation; and
- Reducing equipment emissions.

[11] AENV 2004

5 Reclamation Planning

5.1 Reclamation Plan Development

The objective of reclamation in Alberta is to return disturbed land to a land capability that is equivalent to, or greater than what existed before. End land-use must be identified in the CRPB, prior to receiving approval for an SML. Reclamation is to conform to reclamation criteria of the day. Anything that varies from criteria needs to be specifically agreed to in the CRBP. Operators must also receive a Reclamation Certificate upon completion of their operation. Operators remain liable for all conservation and reclamation (including site clean-up) issues until a Reclamation Certificate is received.

End land-uses are site specific and will depend primarily on the pre-disturbance condition. The choice of an end land-use will depend on the following factors:

- **Regional Limitations** – The natural environment surrounding a site will strongly influence the types of end land-uses that are attainable. Climate, soil type, and landforms available in the region will influence the plant types that can grow in the region. Vegetation on reclaimed land must be self-sustaining under normal management, which means plant communities becoming established and mature without an ongoing, external source of nutrients, water, seeds or seedlings.
- **Size and Depth of the Pit** – In general, if a pit is less than 2 ha, it is recommended that any pit be returned to similar use as adjacent lands where possible. Shallow pits less than three metres deep should not be used for fish habitat. Specific information regarding pit reclamation can be obtained from the "*Guideline for Acquiring Surface Material Dispositions on Public Land*".
- **Surrounding Land Uses** – The end land-use should be compatible with adjacent lands.
- **Costs** – The overall cost may dictate the type of land-use. Applicants must work with ASRD prior to obtaining a licence or lease to determine the final end land-use. Costs for conservation and reclamation should be indentified in the CRBP. It is not appropriate to re-evaluate costs at the end of a pit life and determine that conservation and reclamation plans are cost prohibitive. Pit end land-uses must be identified in the CRBP and adhered to at the end of a pit life.

Table 4 provides a list of possible end land-uses based on the region where the work is occurring.

Table 4: Possible end land-uses for each of the four natural regions (adapted from Green et al 1992).

	Native Grassland	Forestry	Wildlife Habitat	Waterbody	Wetland
Grassland	✓		✓		✓
Aspen Parkland	✓		✓	✓	✓
Boreal Forest		✓	✓	✓	✓
Foothills		✓	✓		

Reclaimed sites must also be self-sustaining over the long-term and able to recover from natural disturbances such as fire, floods or drought at a rate similar to representative undisturbed land. The following section describes three commonly used end land-uses.

5.2 Planning End Land Uses Up Front

5.2.1 Native Grasslands

Native grasslands are defined as grasslands where the dominant vegetation features comprise native grass species and associated forbs and woody species, and occur in one of the natural subregions. In some cases, native grasslands may be modified because of disturbance and include a percentage of non-native species. The end-goal for native grasslands is to be planned, protected, used, managed, reclaimed, and monitored to ensure it is sustainable, healthy and functional native grassland.

For native grasslands being disturbed and reclaimed using adapted and representative native species or cultivars, the reclamation pathway and end-goal is the same as above. The use of short-lived, agronomic species (annuals and short-lived perennials) may be included to obtain quick germination and establishment, and control erosion. These short-lived species must not interfere with the long-term establishment of native species. For example, long-lived native sod forming perennial grass should be avoided as these would also interfere with establishment of native species.

The reclamation assessment of native grassland requires knowledge of the natural subregion in which the native grassland is located, and it's associated native plant communities, environmental and site parameters. This knowledge and adjacent control information will guide the reclamation assessment planning and decisions on reclamation certification. In native grassland communities, the desired outcome is almost always to return the land to pre-disturbance land-use.

Factors Affecting Grassland Restoration

- Plant selection
- Soil type
- Planting technique (drill)
- Time of year
- Seeding rate
- Site preparation
- Seed quality
- Site Maintenance
- Soil Moisture

Source: Hays 2005

When selecting native seed mixes, contact the local ASRD representative. The "*Native Plant Revegetation Guidelines for Alberta*[12]" and the "*Petroleum Industry Activity in Native Prairie and Parkland Areas Guidelines for Minimizing Surface Disturbance*[13]" are excellent publications which can guide the restoration of native grasslands. There are now at least four native seed dealers in Western Canada who supply native grass and flower seed from Canadian locations[14]. Always insist on using native genetic stock that is certified weed free. Some suppliers will package seed that contains non-native species that can become established weed species in Alberta.

5.2.2 Forested Lands

Successful reclamation of forested landscapes assumes the establishment of woody and herbaceous forest plant communities (forest trees and plants). The goal is to develop the site to match pre-existing conditions. Equivalent capability for forested landscapes is defined by ASRD as "the condition in which ecosystem processes are functioning in a manner that will support the production of ecosystem goods and services consistent in quality and quantity as was present prior to disturbance".

Forested land reclamation will involve management of three factors:

- **Landscape:** For forested lands, surface and subsurface drainage should be consistent with the surrounding landscape and the landscape of the reclaimed site must not pose a negative impact to site capability.
- **Soil:** Topsoil conservation and replacement in reclamation is key to providing nutrients for plant development and a foundation of re-establishing a functioning ecosystem. Assurances that topsoil has been conserved and redistributed satisfactorily is now required in order for a Reclamation Certificate to be issued by ASRD.
- **Vegetation:** Revegetation must meet reclamation standards of the day. Under the current standards, a properly reclaimed site should contain the presence of both herbaceous and woody species that are distributed across the site. The assemblage of woody species should indicate development of an early successional community for the target forest type as described the "*Field Guide to Ecosites of Northern Alberta*[15], *West-Central Alberta*[16]" or "*Southwestern Alberta*[17]". Restricted and noxious weeds must be controlled as per current provincial and municipal weed control regulations. Non-native species are to be used only where their benefits to site properties are known and the species are part of a plan to improve and/or stabilize a site. These species should not be persistent and cannot be used to contribute to meeting the vegetation goals. For example, the use of agronomic annuals for early erosion control is an appropriate use of non-native species.

[12] Native Plant Working Group 2001

[13] Native Prairie Guidelines Working Group 2002

[14] Trottier 2002

[15] Beckingham and Archibald 1996

[16] Bechingham et al 1996

[17] Archibald et al 1996

5.2.3 Wildlife Habitat

The relative value of a reclaimed site for wildlife habitat is determined by the following:

- Its contribution to the overall food, cover, and space requirements of indigenous wildlife species;
- The degree to which diverse and productive, pre-disturbance natural vegetation communities and habitat types are re-established, including wetlands and open waterbodies; and
- The degree to which pre-disturbance and special habitat features are re-established, such as natural mineral licks, cliffs and caves.

In planning to re-establish wildlife habitat, the surrounding vegetation types should be examined and the types of wildlife habitat that are in the operating area should be discussed with the local ASRD representative.

The wildlife species and associated habitats of management concern should be identified by referring to land use guidelines that have been developed for selected wildlife species and key wildlife areas. ASRD has a series of Wildlife Land Use Guideline publications for species such as mountain goat, trumpeter swan and key ungulate areas to name a few[18].

The following standards must be met during activities:

- Wildlife dens or nests should not be destroyed or disturbed, particularly for endangered or at-risk species.
- All restrictions for wildlife control areas and seasonal sanctuaries should be followed (i.e., surface access and specific types of activities that are restricted during specific times of the year).
- All restrictions for surface access and specific types of activities within habitat conservation areas should be followed (see *Wildlife Act* and regulations, and associated management plans for individual habitat conservation areas).

[18] Guidelines may be obtained from the ASRD website

5.2.4 Wetlands

Most aggregate pits will have a large end pit that will remain at the end of gravel extraction. In most cases, sufficient overburden will not be available to fill in the pit. If gravel excavation has occurred below the existing groundwater table, there may be an opportunity to create a small pond or wetland.

Wetlands provide several important uses and functions:

- Water storage;
- Groundwater recharge;
- Flood control (by detention or depression storage);
- Storm runoff control;;
- Water treatment;
- Carbon storage;
- Trapping of fur-bearers;
- Fishing and waterfowl hunting; and
- Recreation.

The reclamation of gravel pits to wetlands requires an awareness of the regulatory and planning policies of the region. These include legislated obligations (Alberta *Water Act*, Alberta and *Environmental Protection and Enhancement Act*), management strategies (i.e., the Water for Life Strategy) and regional planning. The purpose of a wetlands restoration is to create an initial condition for wetland establishment. A useful source of information for creating wetlands in the boreal forest region is the "*Guideline for Wetland Establishment on Reclaimed Oil Sands Leased Revised*[19]".

[19] Harris 2007

6 Best Management Practices

Best management practices (BMPs) are non-regulatory management and operational approaches based on past experiences. If followed, they should allow the operator to not only meet the required standards, and also prevent or mitigate any undesirable environmental effects or unforeseen complications associated with aggregate extraction. The underlying principle of BMPs is continual improvement. BMPs should be used appropriately and under the right circumstances. They can be used independently or in combination. It is up to the operator to use their best judgement to determine when the application of a BMP is safe and appropriate. Site operators are encouraged to use a combination of the BMPs presented in this document, as appropriate for their operation, to ensure a high level of protection for the community and the environment.

This section of the manual provides examples of BMPs that can be applied to mitigate common environmental concerns associated with aggregate extraction on Public Land. The BMPs presented in this manual are based on four main principles:

Planning – Plan Ahead! Operations should be planned to efficiently extract the resource and progressively reclaim the pit[20]. Utilize the BMPs presented in the manual or other BMPs that may not be included in the manual as applicable to plan activities during the development of the CRBP.

Scheduling – Schedule activities so that they coincide with the optimal period for undertaking the activity. For example, schedule site preparation activities such as creating roads and ditches during dry periods.

Vegetation Management – Vegetation management is critical for managing erosion and sedimentation on a site. It is a cost effective way to manage noise, dust and visual concerns. Maintain as much vegetation onsite as possible.

Soil Conservation – Use erosion and sediment control options to conserve soil. Topsoil should never leave the site and should be stored and managed properly onsite.

6.1 Planning and Site Development

Proper site planning is in everyone's best interest. A well developed CRBP will increase the efficiency and profitability of the operation. In some cases, project planning is the most critical phase for developing an operation. A well planned site will ensure that any disturbances to adjacent lands are minimized, while hazards such as dust, water contamination, and erosion will be mitigated or completely avoided.

[20] AENV 2004

The first step in planning an operation involves collecting and reviewing information that may be available concerning existing site conditions[21]. Prior to applying for an SML, evidence of surface material type and quantity must be verified. To properly outline and describe the resource, a Surface Exploration Permit (or SME) is strongly recommended. The SME should delineate the aggregate reserve and other important subsurface parameters. More information regarding the developing the SME is available in the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[22]". The SME should identify the groundwater conditions at the site. If aggregate is to be mined below the water table, then an approval may be required under the *Water Act*. A Temporary Field Authorization (TFA) may also be required if pit water has to be discharged outside the operating area. Field investigations will be required to obtain the data for the SME.

Information is also required for the land use investigation, which identifies land-use dispositions, municipal zoning restrictions and other land-use activities. Examples include timber permits and First Nations considerations. Information regarding the biophysical resources within the project area must also be presented. Any SML and CRBP submission must provide information about the environmental resources in the project area and identify any positive or negative changes that the operation may have on the resources. Environmental resources include:

- Fish and wildlife habitat;
- Vegetation and soil;
- Groundwater and surface water features; and
- Historical, archaeological and paleontological features.

In many cases, changes to the environmental resource can be addressed through the application of mitigation measures. Applicants are encouraged to apply the BMPs presented in this manual to address mitigation of environmental resources.

- **Location of the Pit** – This will be determined by the location of the deposit and any sensitive environmental features such as a watercourse.
- **Size, Shape and Depth** – Overburden distribution and groundwater depth will largely determine the size and depth of the operation.
- **Buffer Zones** – Undisturbed buffer zones must be incorporated into the site plan along property boundaries, road allowances and to protect sensitive areas. Buffers are typically required around property boundaries and sensitive areas. These buffers will be determined by ASRD based on the sensitivity of the feature. For example, a 100 m buffer may be required by ASRD around any sensitive waterways. Site specific conditions will define appropriate buffer size. Buffers are discussed further in Section 6.2.2 and Appendix B.

[21] Green et al 1992

[22] ASRD 2007

- **Stockpile Sites** – Stockpile sites should be identified before clearing and extraction begins. Long-term storage of topsoil should minimize the number of times the stockpile is moved (See Section 6.3.6 for more tips on topsoil stockpiling). Topsoil and subsoil should be stored separately to reduce the chance for soils to be mixed (topsoil is valuable reclamation material!). The total area required for stockpiling can be determined using soil depth data and can occur during the planning stage.
- **Site Drainage** – The goal of a good site drainage plan is to divert the water around the site to minimize the amount of water in the pit. A drainage management plan may involve the construction of ditches and sediment ponds (see Erosion and Sediment Control discussion in Section 6.6). These must be identified up front. A licence will be required from Alberta Environment to discharge any water into a natural watercourse or waterbody. A Temporary Field Authorization may be required to discharge onto adjacent land.
- **Progressive Reclamation** – Progressive reclamation practices must be applied to all sites. Progressive reclamation practices will reduce double handling of soil and maintain the viability of topsoil stockpiles.
- **Native Vegetation** – Native vegetation must be used during all reclamation and revegetation activities. Work with an ASRD representative to determine the best source for weed-free seed.
- **Work with your Local ASRD Representative** – Most issues related to material extraction, potential land-use conflicts and environmental considerations are site specific. It is important to contact your local ASRD representative up-front to identify any potential issues as well as discuss potential mitigation for environmental considerations. Working with ASRD from the beginning can reduce the amount of time required to process a permit.

6.2 Vegetation

6.2.1 Clearing and Grubbing

Timber salvage and grubbing occurs as a first step for developing a site. Trees and vegetation are salvaged and grubbed to allow for the development of roads, buildings, stockpiling sites and the pit. Applicants should contact the Alberta Natural Heritage Information Centre (ANHIC) to determine whether any rare plants occur within the site area. Any timing restrictions (i.e., migratory birds or species at risk restrictions) must be identified up front and salvage and grubbing activities should take place around those restrictions.

All merchantable timber should be salvaged. SML holders are required to determine ownership or rights to the timber resource before proceeding

with timber removal. If an existing timber licence or permit authority does not exist within the SML boundary, the SML holder must contact ASRD to obtain one of the following:

- **Obtain a Permit** - A Local Timber Permit (LTP) or Commercial Timber Permit (CTP); or
- **Request a Waiver** - Request a waiver of the timber resource by ASRD. A waiver can be obtained if the timber is either non-merchantable or insufficient economic volume of merchantable timber for waiver consideration.

If a licence for the timber resource does exist, then the timber rights holder must be contacted by the SML holder to coordinate the timber harvest with the development of the gravel operation. A consultation should occur between the SML holder and timber license holder including harvesting entity, where log decks shall be placed, transport and removal of logs, etc. The SML may also be required to pay the timber licence holder for the loss of timber prior to development of the site. The timber planning component phase should be completed prior to commencement of SML field operations. It is in the best interest of the SML holder to coordinate timber operations with the timber rights holder, ensuring operational compatibility for both disposition holders.

It is recommended that timber be put to some beneficial use or that operators dispose of it by sale or gift[23]. Timber may be retained for another stage of the operation and large woody debris is sometimes used as fish habitat when the proposed end land-use is a waterbody[24]. If the lease holder wishes to burn the excess roots and stumps, then they may require a burn permit from ASRD. Unburned grubbing should never be buried, as decomposing material can create a void which can cause serious problems in the future.

The following are examples of BMPs that can be used during the clearing and grubbing stage of an operation.

6.2.2 Site Preparation

- All surveyed dispositions legal boundaries should be clearly marked and visible.
- The CRBP should identify which areas will be cleared, the location and extent of any buffers and setbacks, as well as how grubbing material can be used onsite.
- Awareness of buffer and setback locations can prevent any unnecessary disturbance within these areas. Identify buffers and setbacks on a map or flag these areas prior to development. Maps can be provided to machine operators or reviewed during tailgate meetings.

[23] Stated in section 150 of the Timber Management Regulations of the Forest Act.

[24] Waterbodies as end land-uses require approval from AENV.

What is a Riparian Buffer?

Riparian buffer zones are strips of permanent vegetation adjacent to stream, rivers and lakes. They are transitional areas between aquatic ecosystems and upland ecosystems.

Why are Riparian Buffers so Important?

- Improve water quality by filtering out sediment and pollutants
- Maintain cool water by shading streams and rivers. This is critical for many fish species in Alberta.
- Roots of vegetation will stabilize banks and prevent erosion.
- Provide habitat for a large variety of plant and animal species both on land and in the water.

How wide should it be?

The appropriate buffer width will depend on the region and the plants and animals that inhabit the area. For example, a study by Darveau et al (1995) determined that 50 metre wide buffers were for forest dwelling bird species. Buffer strips of at least 30 metre wide allowed for the normal development of salmonids eggs by reducing sedimentation.

Source: Fisher and Fieschenich 2000

Buffers

- The final width of the buffer will be determined by ASRD and in some cases can be as wide as 200 metres, depending on the type of waterbody. Buffers may be required around wildlife corridors and other sensitive areas. Site specific conditions will define the appropriate buffer size.
- A three metre wide buffer is required around the property boundary.

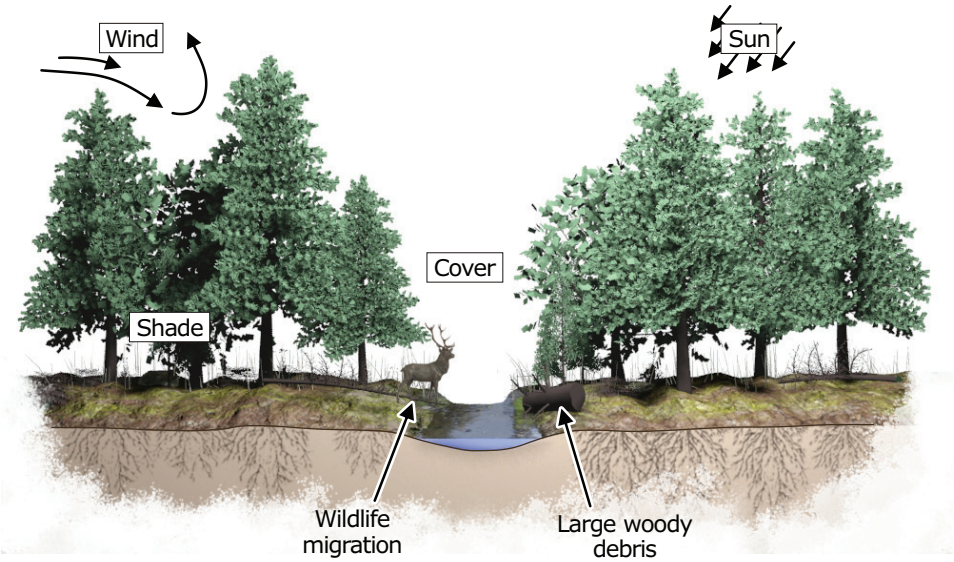


Figure 3: A riparian buffer can improve water quality, shade streams, and provide habitat for many terrestrial and aquatic species.

Setbacks

- Extraction setbacks may be recommended to further protect buffer zones. The extraction setback should be equal to the average depth of the pit multiplied by 1.5 for property boundaries where a 3:1 slope is to be established. Further guidance on extraction setbacks is available in the "*Code of Practice for Pits*[25]" and the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[26]".
- Extraction setbacks may be required around sensitive features such as waterbodies, riparian buffers, wetlands, coulees, river valleys, rare landforms, rare plants and sensitive or important wildlife areas. ASRD wildlife and fisheries biologists will determine where setbacks are necessary and how large they will be.

[25] AENV 2004

[26] ASRD 2007

Erosion and Sediment Control

- Proper erosion and sediment control techniques should be used to minimize soil loss during clearing and grubbing (see Section 6.6 for more information on erosion and sediment management). Clearing vegetation and timber exposes soil, making it more susceptible to erosion.

Clearing

- Clearing and grubbing should only occur where absolutely necessary. Standing vegetation and ground cover is useful for filtering surface runoff sediment, blocking noise and wind, camouflaging activities and maintaining a visually appealing site. Dead trees and snags can act as important wildlife habitat and should not be cleared unless necessary.
- In some instances (e.g., rough fescue prairie), native plant communities are difficult to re-establish. Leaving as much vegetation on site as possible will reduce reclamation costs and improve reclamation success.

6.2.3 Salvage

- Determine ahead of time how, and by whom, timber should be salvaged. It is the responsibility of the lease holder to know whether there is an existing timber licence or FMA holder for the project area.
- Lease holders are encouraged to work with their local ASRD representative to determine the proper use for salvaged timber.

6.2.4 Grubbing

- Depending on the region, grubbing may be required after the timber salvage is complete. Large diameter material (>2.5 cm) should be removed by grubbing prior to soil salvage.
- Grubbing is typically not required in grass dominated landscapes, as large diameter woody material is not present on these sites. Any small woody debris can be salvaged with topsoil at grassy sites.
- Grubbing should be done in frozen or dry conditions, so as not to compact top soil.
- Avoid grubbing within 2 m of any standing timber to prevent damage to remaining root systems.
- Consider future use of grubbed material. Grubbing material can be used as access restricting roll back, and can provide assistance with stabilizing soils and slopes, moisture retention, developing wildlife micro-sites, building site bio-mass, and nutrient recycling during reclamation. In some instances it is not desirable to maintain

grubbing material onsite. Work with an ASRD representative to determine the best use for these materials.

6.2.5 Disposal

- ASRD encourages all disposition holders to maintain all grubbing materials onsite to be stored for later use during reclamation or disposed of onsite.
- Some operators mulch/slash non-merchantable timber into coarse mulched material or coarse wood chips. Alberta Sustainable Resources Development (ASRD) has published a directive called "Management of Wood Chips on Public Land (2009)". Please refer to this directive for additional direction on how to manage wood chips on public land.
- Operators may choose to burn grubbing materials. Municipal and provincial restrictions may apply throughout the year. A provincial burning permit is required within the green zone between April 1 and October 30. It is important to check with a local ASRD office for restrictions, prior to burning.
- Long-term onsite storage may be an option and should be identified in the CRBP. Long-term storage sites must meet the fire protection standards for wildfire hazard abatement in the *Forest and Prairie Protection Regulations* Parts 1 & 2, under the *Forest and Prairie Protection Act*.
- Cleared and grubbed materials should remain away from drainage areas so as to not block drainage.

6.2.6 Revegetation

Once the site has been contoured and soils have been replaced, vegetation should be established as soon as possible. Depending on the end land use, efforts must be made to cover exposed soil with native vegetation to eliminate future erosion and sedimentation issues.

Planning

- It is important to consider establishment rates for different species.
- A revegetation plan must be identified in the CRBP. Applicants must review the "*Native Plant Revegetation Guidelines for Alberta*[27]" when developing a revegetation plan.

Timing

- Revegetation of disturbed areas should be phased to limit exposed soil areas at any one time.

[27] Native Plant Working Group 2001

Seed Source

- Seed and stock for grasses, legumes, shrubs and trees should also be obtained from local sources whenever practical.
- Store bought seed sources should be certified weed free to avoid introducing weeds to the area.

Erosion and Sediment Control

- An initial cover of barley, rye or flax in conjunction with an ASRD approved grass/forb mix should be planted immediately for erosion control and long-term stability. Trees and shrubs can be planted as needed.
- Temporary revegetation should be considered to minimize erosion along road cuts and ditches. Lining ditches with grass can reduce water velocities and filter sediment (Section 6.6 and Appendix B).

Weed Management

- Noxious and restricted weed control should be undertaken as required.
- Efforts should be made to ensure that non-native species are not introduced to the site.

6.3 Weed Management

Weed management is a serious concern within the province of Alberta. The *Weed Control Act* of Alberta governs the legislation of restricted, noxious and nuisance invasive plant species or weeds. A list of noxious and nuisance weeds is presented in Section 4.2.4. Aggregate operations are particularly susceptible to weed establishment, as disturbed soils are often left exposed. Exposed soils offer excellent conditions for weed establishment. Weeds can be transported to aggregate sites as equipment is brought in from other sites. Weeds can be introduced on-site through the use of seed mixes to stabilize soils. These products should always be certified weed free.

An SML provides the lease holder the authority to operate on public land. With this authority the lease holder accepts the legal responsibility to control weeds within the project area. This responsibility includes:

- **Destroy, Control and Prevent** – The lease holder must destroy all restricted weeds, control all noxious weeds (Table 3), and prevent the spread of nuisance weeds.
- **Prevent the Introduction** – The lease holder must not introduce any weeds to a site through the use of seed or by way of equipment.
- **Weed-Free Seed** – The lease holder must use first class seed that is free of weeds.

The following BMPs can help prevent the spread or establishment of weeds during the course of an operation.

- Any weed species at, or near, the site should be documented and reported in the CRBP. Photographs should be taken of any weed species.
- If possible, check for weed species on adjacent lands to determine weed species presence. This can become important if conflicts arise about the introduction of a weed species.
- Municipalities can upgrade the status of a weed species. Check with the Municipality for any changes to the weed list.
- Operators can contact the local weed inspector to determine which weed species are present in the area.

6.3.1 Prevention

Limit Disturbance

- Attempts can be made to limit disturbance to soil wherever possible. Weeds will often establish in disturbed soils.

Equipment

- All equipment working on the site should be cleaned of mud and vegetation (via steam cleaning or high-pressure power washing) prior to moving onto the work area or moving to another site, to avoid transferring or introducing non-native or undesirable species and organisms to the site. Should an area of high weed infestation be encountered, re-clean construction vehicles and equipment prior to advancing to a weed-free area.

Topsoil

- Seed subsoil and overburden stockpiles can prevent weed invasion; however, seeding topsoil in forested areas may limit the opportunity for native species to establish on stockpiles. Seeding should not be the first option for upland surface soils. Topsoil should be left to revegetate naturally.
- Do not bring topsoil from another site. Manage topsoil throughout the life of an operation so that it can be used during reclamation.

Weed-Free Seed Mixes

- Certified weed-free seed mixes and mulch should be used to seed stockpiles and stabilize soils after disturbance. Retain the analysis certificate in case a dispute arises concerning weeds.

Revegetation

- By implementing revegetation of disturbed areas as soon as possible following construction, operators will minimize the amount of time soil is left exposed and reduce the chances that weeds become established.

6.3.2 Maintenance

- A weed maintenance program throughout the life of the pit can reduce the spread of existing weed species. More information regarding controlling the spread of invasive weeds can be found at the Government of Alberta's Agriculture and Rural Development website http://www.agric.gov.ab.ca/

Mowing

- Mowing weeds prior to flowering can prevent them from spreading.
- Do not apply fertilizer to reclaimed areas with known weed infestations, because nutrients can enhance the growth of weeds.

6.4 Soil

Conservation of soil is necessary for restoring ecological structure to a site during reclamation. The conservation of topsoil is also required by law; topsoil conservation is required under the *Conservation and Reclamation Regulation* under *EPEA* and the *Soil Conservation Act*. For this reason, salvage and subsequent storage of the soil requires planning and commitment. The ultimate goal during soil salvage and stockpiling is to preserve the original quantity and quality of the topsoil so that land can be restored to a productive state for future use.

6.4.1 What is Topsoil?

Topsoil is the uppermost layer of the soil. It is defined as the "A horizon" under the "*Canadian System of Soil Classification*[28]". Topsoil is generally much darker and has a much higher organic content than the deeper subsoil. Topsoil is the most fertile portion of soil, as it is nutrient rich and contains microorganisms and seeds which are really important factors for vegetation growth. It takes approximately 500 years, under natural conditions, to produce an inch of topsoil and for this reason it must be considered a very valuable resource. In forested areas, topsoil includes the forest floor, the organic or duff layer. The organic layer also known as the "O horizon" is the organic materials that occur from the accumulation of leaves, twigs, and woody materials which overlies a mineral soil.

[28] Agriculture and Agri-Food Canada. 1998

6.4.2 What is Subsoil?

The subsoil, or "B horizon", as defined by the "Canadian System of Soil Classification[29]" is a mineral layer which is formed as minerals are leached from the topsoil layer. Subsoil is located beneath the topsoil but above the overburden or bedrock. Plant roots may penetrate through this layer; however, it is much less productive but much deeper than the topsoil. Subsoil is typically brownish or red in colour because of the clay and iron oxides that wash down from the topsoil layer. In the prairie regions of Alberta, subsoil can vary in colour and is often indistinguishable from the topsoil by colour.

6.4.3 What is Overburden?

The overburden layer is located below the subsoil layer but above the aggregate deposit. This layer may contain large clusters of un-weathered cobble and boulders and is often described as "waste" rock. Overburden materials can be useful as fill and a contouring material during reclamation.

6.4.4 How Can Soil Loss Occur During an Operation?

Before aggregates are extracted from the earth, the soil and overburden are removed and stored onsite for future use. During the removal and storage of the soil, there is potential for topsoil loss to occur. Topsoil losses can occur through:

- poor or incomplete salvage;
- mixing topsoil and less productive subsoils or overburden during the salvage;
- erosion of topsoil piles throughout the operation by wind or water;
- missing topsoil piles as they can become buried under aggregate stockpiles;
- missing topsoil piles as locations are not mapped and location information is lost;
- theft of topsoil from the site; and
- contamination of topsoil by oil from machinery or aggregate by-products. This may include human created contaminants or natural contaminants such as sulphides or salts.

Soil must be properly managed throughout the operation and should be returned to the disturbed land once the operation is complete. Properly managing soil throughout the life of an operation will improve the chances

[29] Agriculture and Agri-Food Canada. 1998

of successfully reclaiming the land. Without proper topsoil salvage and storage, operators may find themselves with a shortage for covering regraded areas during reclamation.

The following BMPs can be used to maintain the quality of topsoil at a site. Remember that not all BMPs will apply and it is the job of the operator to determine which ones will work best at a site.

6.4.5 Soil Salvage

Soil Assessment and Mapping

- A soil assessment will describe the kind, extent, depth, location, and quality of topsoil, subsoil and the overburden within the proposed operation area. Topsoil texture should be described using "*The System of Soil Classification for Canada, Third Edition*[30]". Depths of soil types, including topsoil, subsoil and overburden, will determine salvage depths. The soil type and quality will also help determine the end-use for the site.
- Topsoil "depth variability checks" is a useful tool for planning soil salvage depth in areas where soil may be unusually thick or thin. These are completed by taking several auger cores in a 3 metre circle regular pattern throughout the site.
- The volumes of topsoil and subsoil can be estimated through a soil pre-site assessment and will assist in determining the best methods for removing and storing soil. The volume of soil will determine where it is stored (i.e., how much area will be needed).
- The soil assessment and soil map should be created by a qualified soil specialist, someone who has experience working with soils[31]. The specialist should:
- Use an appropriate inspection density as outlined in the "*Soil Quality Criteria Relative to Disturbance and Reclamation (Revised)*[32]";
- Conduct inventory at the proper time (e.g. avoid frozen conditions, do not survey in the dark); and
- Use soil descriptions and classifications as outlined in "*The System of Soil Classification for Canada, Third Edition*[33]".
- The extent of overburden and aggregate deposit should be determined using auger drilling, backhoe test pitting, or both.

The CRBP should contain information regarding thickness of topsoil, subsoil, overburden and aggregate. This information should be used to direct soil salvage and storage needs. This information will also be used to set reclamation goals.

[30] Agriculture and Agri-Food Canada, 1998

[31] AENV 1999

[32] Alberta Soils Advisory Committee, 1993

[33] Agriculture and Agri-Food Canada, 1998

Figure 4: Topsoil, subsoil and overburden should be removed separately.

Timing

- It is best not to carry out topsoil salvage when the soil contains excessive moisture. Generally, if the soil sticks to the equipment, it is too wet to salvage. In wet areas, where the soil is permanently saturated, soil should generally be salvaged when it is under frozen conditions.
- In dry areas with dry soils, topsoil salvage is most effectively carried out when the ground is not frozen. It is much more difficult to salvage topsoil separately from the underlying subsoil when the surface is frozen.

6.4.6 Stripping

- Soil must only be stripped from areas that will be disturbed by the operation such as the pit area, roads, and storage areas.
- If the topsoil layer is less than 15 cm thick, then a minimum of 15 cm of material should be salvaged unless part of the material is not suitable for use during reclamation (e.g., bedrock or gravel).
- In forested areas, topsoil can be salvaged with the organic or "duff" layer of material on the forest floor.
- Topsoil, subsoil and overburden must be salvaged and stored separately. Mixing the layers will affect the quality of the topsoil and your reclamation success.

- Topsoil salvage depths should be determined prior to stripping. Topsoil salvage depths will vary depending on where the operation is located across the province. For example, mountainous areas may have very little topsoil.
- A test trench can be dug prior to salvage to visually assess the depth of the topsoil and subsoil layers. Pedestals, which are small islands of topsoil, can be left throughout the salvage area to verify soil removal depth.
- Topsoil should be salvaged at least 5 metres ahead of all pit faces; subsoil should be salvaged 3 metres ahead of all pit faces. This buffered area will ensure that topsoil does not slough into the pit. Salvage distance around the pit should be greater than 5 metres if the pit face is unstable or rapidly advancing.
- Pit walls should be sloped as approved in the CRBP as soon as possible to minimize the amount of time they are left at a vertical drop.
- On-site supervision, by technically qualified soil personnel, during topsoil salvage operations can improve the identification of the soil layers (topsoil vs. subsoil) and improve stripping control.
- Stripping should be discontinued if groundwater is encountered and was not anticipated and identified in the CRBP. ASRD and AENV should be notified as permits may be required under the *Water Act*.

6.4.7 Soil Stockpiling

Using the soil assessment results and SME test data, estimate ahead of time how much topsoil, subsoil and overburden are present at the site. The volumes of topsoil and subsoil can be determined through a soil assessment and will assist in determining the best methods for removing and storing soil. The volume of soil will dictate where it is stored based on the space required (assume maximum 5m soil stockpile height).

Drainage

- When stripping a surface for the soil stockpile, create a smooth, slightly sloped area to promote drainage. Soil stockpiles are best situated on level or gently sloped ground <5% which will encourage drainage from the piles.

Location

- Piling soil in a windrow formation (as opposed to a conical mass) will reduce soil compaction, slope failure hazards and promote wildlife movement. Conical piling is appropriate for overburden piles.

- Breaks within the windrows at 100 m intervals are sufficient for providing surface drainage and exit routes.
- It is recommended that no more than 50% of the perimeter contain continuous berm.
- When choosing a location to store your soil, look for areas without merchantable aggregate. This will avoid having to move the stockpiles twice and reduce the chance of soils becoming compacted.
- Consider storing topsoil on the leeward side of the active pit, or where possible to avoid wind erosion.
- Practice progressive reclamation. Re-spreading is easier and more economical when topsoil is stockpiled in small stockpiles close to the area where it will be used.
- Select stockpile locations that are away from construction areas, high traffic areas, slope, natural drainage areas and out of the wind. Wind and water can erode the storage piles and result in a loss of soil. High traffic areas can create wind and cause erosion.
- Prevent traffic from driving over soil stockpiles. Loaders should load and unload from the bottom of the pile. The weight of the vehicles on the stockpile will increase compaction of the soil and reduce the overall quality of the soil.
- Keep soil stockpiled within the permitted area.
- Topsoil, subsoil and overburden must be stored separately. Mixing the layers will affect the quality of the topsoil and your reclamation success.

Identification

- Identify soil stockpile locations in the site plan. Make sure to clearly identify topsoil sites separately from subsoil and overburden piles.
- Stock piles should be clearly labeled with signs on site as well.

Height

- Thin, vegetated soil stockpiles up to 5 metres are recommended for maintaining topsoil quality. Stockpiles 1.5 metres high will stay healthy for up to a year; after that the structure and chemical composition can gradually deteriorate It is best to minimize the amount of time that topsoil remains stockpiled.

Erosion Protection

- Subsoil and overburden stockpiles should be seeded to stabilize the pile. Vegetating stockpile will help maintain the viability of the soil. Soil stockpiles should be seeded, if possible, within 30 days of forming the stockpile. Upland surface soils (i.e. forest floor plus topsoil) should be allowed to naturally revegetate.
- If storing soil stockpiles for short periods of time (i.e. < than 1 year) use an annual cover crop for seeding. Contact ASRD to determine which seed type is best suited for the region.
- If storing soil stockpiles for a longer period of time (i.e. > than 1 year), seed stockpiles with an approved final reclamation species that can establish for longer periods of time. ASRD staff can assist with choosing appropriate seed types.
- Tarpaulins can be used to temporarily protect stockpiles.
- If erosion will be a potential issue, use sediment barriers to prevent the topsoil from leaving the site. Silt fences, mulches, tarpaulins, can all be used to prevent erosion. The goal is to minimize the loss of soil through erosion and prevent soil from leaving the site. Erosion control is explained in further detail in Section 6.6.

6.4.8 Soil Replacement

- Soil should be replaced in a manner that creates a reconstructed soil of equal or greater productive capacity than the pre-disturbance condition.

Timing

- Avoid moving soil during adverse or wet periods. Moving soil when it is wet can cause unnecessary compaction and reduce reclamation success.

Site Preparation

- Grade the surface as needed to prepare the site.
- Loosen the earth, by scarifying to a depth of 50 - 150 mm before covering with the next layer, which will reduce compaction and hardening.
- Decompacting the subsoil (i.e. overburden or subsoil) by ripping prior to topsoil replacement will increase infiltration of surface water, and creating a better root zone to improve reclamation success.

Soil Replacement

- Ensure that subsoil and topsoil are replaced in the reverse order that they were removed (e.g. poor quality overburden, reject material and fine sediment should be placed directly in the pit and can be used around the site for grading and contouring). Topsoil should always go on top.
- All salvage soils and overburden must be replaced. At least 0.5 - 1 metres of better quality material (higher quality overburden, subsoil or topsoil) should be placed above the poor quality material (gravel) to ensure the establishment of a suitable root zone.
- Equipment operators should be aware of compaction issues. Loading from the base of the stockpile, when using tracked or wheeled loaders, will reduce compaction.
- Using the soil map as a guide, redistribute soil uniformly to pre-disturbance thickness.
- Use the following Table 5 to determine the volume of topsoil required to various depths.

Table 5: Volumes of topsoil required for replacing various depths (Source: BC Ministry of Energy and Mines)

Depth (mm)	Cubic Metres per 100 square metres	Cubic Metres per Hectare
25	2.5	250
50	5.0	500
75	7.5	750
100	10.0	1000
125	12.5	1250
150	15.0	1500

- Rough features such as stumps, roots, lumps of sod or rock can be incorporated into the surface landscape to increase roughness.
- The topsoil layer (8 – 10 cm) should be left rough, with some variability in soil depth which will trap moisture and seeds, creating a more diverse plant community. This applies to both forested and grassland ecosystems[34].
- In agricultural areas, the subsoil should be worked to break up lumps and to level ridges prior to topsoil replacement[35].
- Contouring will help establish site drainage. Replaced soil should be integrated into local drainage patterns and topography.

[34] MuCullah 2009

[35] AENV 2004

- In agricultural areas, topsoil should be replaced as evenly as possible across the site but not below the water table.
- If a waterbody is the desired final land end-use, a thin layer of topsoil can be applied within the littoral zone which will help establish aquatic vegetation[36].

Decompaction

- Replacing overburden in thick (one metre) lifts should help to reduce compaction on a site.
- Subsoilers can be used to relieve compaction in the subsoil after the topsoil has been replaced. Experienced personnel should be present to monitor and supervise the work and make adjustments as deemed necessary[37].

Maintenance

- Keeping haulage roads well-defined will ensure that vehicles do not run over recently placed topsoil or subsoil, which will prevent compaction.

6.5 Stormwater Management

Stormwater is rainfall or snowmelt that does not infiltrate into the ground and flows across a site. As it moves across a site, stormwater can cause erosion and collect sediment and pollutants.

Stormwater management involves planning for, and controlling, stormwater runoff for the purpose of reducing erosion, improving water quality and controlling flooding. Stormwater management is necessary onsite to prevent erosion and sedimentation as well as to keep the site safe for operation. The goal of stormwater management is to:

- Control the flow of water across a site through the use of dykes, swales, ditches, curbs or berms;
- Control erosion by stormwater at a site through construction and maintenance of erosion control measures;
- Manage sedimentation caused by stormwater at a site through the use of sediment basins, sediment traps and other BMPs; and
- Ensure that any discharge from the site is free of pollutants or sediment.

[36] AENV 2004
[37] AENV 2004

Stormwater management is regulated under the Wastewater and Storm Drainage Regulation of EPEA. Through these regulations, the responsibility is placed on the operator to ensure that any discharge from a site is free of pollution or sediment. Because erosion control measures will be site specific, lease holders are encouraged to retain professionals to develop stormwater management plans, design and construct channels.

The BMPs presented in this section are intended to prevent erosion and enhance the amount of water infiltrated into the soil during stormwater events, to minimize flooding of water in nearby watercourses, and to reduce suspended sediment and pollutant concentrations by minimizing the amount of water leaving an operation area. The first step in stormwater management is to reduce the amount of stormwater entering a site. Further onsite erosion and sediment control is required to prevent loss of soil from the site.

6.5.1 Stormwater Diversion

Ditches, swales, berms and retention areas are often used to control stormwater but the best and first option should be to divert stormwater around a site and back into the natural drainage system. A stormwater management plan is a useful tool for identifying key sources of water flowing on the site. Natural drainage on a site can be observed prior to disturbance. Natural drainage patterns can be incorporated into the stormwater management plan. Once natural inputs are identified, then structures such as grass-lined ditches (See Appendix B) can be used to divert water around the site.

Pit floors should be maintained at a gradual slope (i.e. 3 to 5%) during excavation to move surface water to one end of the pit. The bottom slope should be on the downslope side of topography if possible. In some cases this is not possible. Pits should not be allowed to accumulate water and water should be routinely disposed of. This will reduce the chances for water to become contaminated. ASRD may require a water toxicology test to verify that water is within acceptable limits prior to the issuance of a Temporary Field Authorization (TFA) for water disposal.

Seasonal variance in rain and snow should be considered during planning of stockpile locations, wash operations and access routes to the pits.

Figure 5: Stormwater should be diverted around the site to help prevent erosion and sedimentation onsite.

6.6 Erosion and Sediment Control

6.6.1 Erosion Control

Erosion prevention protects the soil surface and prevents the soil particles from being detached by rainfall, runoff, or wind. Natural causes are typically the primary cause of erosion; however, erosion can be accelerated through human activities that expose soil such as removing vegetation, and building roads and parking lots. There are three types of erosion that may occur within a project area:

1. **Raindrop (Splash) Erosion** - Raindrop erosion is caused by the movement of soil particles caused by the direct impact of raindrops on unprotected exposed soil surfaces.
2. **Sheet Erosion** - Sheet erosion is the movement of soil particles caused by runoff flowing over the ground surface. Erosion is caused by shear stresses associated with water flow.
3. **Rill and Gully Erosion** – Rill and gully erosion are the removal of soil along concentrated drainage paths by surface water runoff. Once initiated rills may join, further concentrating flows and eventually developing into gullies. These will continue to erode, side walls will slump and sediment will be transported downstream, unless steps are taken to stabilise the disturbance.

Erosion prevention is generally more effective than sediment control and should be the first line of defence. Erosion prevention BMPs are intended to keep soil in place. When implementing erosion control on a site the following principles should be considered[38]:

- Use the natural topography and vegetation onsite;
- Minimize disturbance to the natural vegetation onsite by clearing only where necessary;
- Minimize the amount of exposed soil at any one time through the use of progressive reclamation;
- Vegetate exposed soils as soon as possible;
- Vegetate temporary soil stockpiles;
- Minimize concentrated flows and divert runoff away from slopes or critical areas;
- Minimize slope steepness and slope length;
- Use temporary drainage structures, such as ditches, to divert upstream water around a site; and
- Use channel linings and other control features, such as check dams, to reduce velocities in temporary drainage structures[39].

Proper timing can also reduce erosion. If constructing ditches or berms, it is best to undertake construction activities in the dry season.

The following BMPs can be used to minimize erosion on-site. As erosion control measures will be site specific lease holders are encouraged to retain professionals to develop stormwater management plans, design and construct channels.

Scheduling

Developing a proper schedule is important to ensure that the work is done in a logical sequence. For example, clearing and stripping for later phases of the project should be done just before it is necessary. While that is occurring, re-vegetation of earlier phases should be underway[40]. Ideally, work should be scheduled when rainfall or spring snowmelt runoff is not expected.

[38] State of Alaska 2006

[39] Do not install check dams or divert flows in natural waterways without approval.

[40] City of Edmonton 2005

Maintain Existing Vegetation

Whenever possible, existing vegetation should be left standing. Existing vegetation acts as an effective vegetative buffer strip as a form of erosion and sediment control by both slowing down the flow of water, to enhance sediment settling, and by allowing sediment filtration to occur. Existing dense vegetation may be more effective than man-made structures or devices for sediment or erosion control. However, additional forms of erosion and sediment control measures will likely be required at aggregate extraction sites.

Any removal of vegetation along steep valley slopes with highly erodible soil will be detrimental and may create long-term erosion problems. It is important to only strip necessary areas immediately required within the areas of extraction. A buffer is mandatory along river valley slopes and along the edge corridor of waterbodies. ASRD will designate the appropriate buffer size based on the sensitivity of the waterway. Keep in mind that very careful planning is required to work around preserved riparian zones. These areas should be flagged and identified on a map prior to clearing.

Timing of Clearing, Grading and Stripping

Areas should be cleared, graded and stripped only as needed for immediate activities. Practicing progressive reclamation will allow natural cover and vegetation to remain in place for as long as possible, possibly minimizing the length of time soil is exposed and the amount of erosion that may occur. Restoration and reclamation of ground cover should be done as soon as possible following extraction or other activities in the area.

Seeding

Seeding is performed to establish vegetative cover in an area, which will in turn stabilize the area. It provides erosion protection through development of a shallow root structure from seed germination and plant growth. Seeding can be either permanent or temporary. Seeding helps prevent erosion and sedimentation, and also enhances terrestrial and aquatic habitat vegetation.

For seeding to be successful, careful planning is critical. A good knowledge of the soil characteristics is essential and appropriate seed mixes should be selected. Planting should occur at the appropriate time for the particular seed being used, and continued watering and maintenance is essential. More details on seeding are provided in Appendix B.

[38] State of Alaska 2006

[39] Do not install check dams or divert flows in natural waterways without approval.

[40] City of Edmonton 2005

Mulching

Mulching is the application of organic material or other normally biodegradable substances as a protective layer to the soil surface to:

- Minimize raindrop/runoff erosion and conserve soil moisture for plant growth, and/or
- Promote seed germination and plant growth.

Mulches conserve soil moisture, reduce runoff velocities and surface erosion, control weeds, help establish plant cover, and protect seeds from predators, raindrop impact, and wind/water erosion.

Mulches can be both temporary and permanent erosion control measures. They can be used as an organic cover or growth medium for seeds where topsoil is not readily available. This is a relatively cheap method of promoting plan growth and slope protection. Hydro-mulching is preferred on very steep or rocky/gravelly slopes. Additional details on mulching are provided in Appendix B.

It must be noted that too much mulch applied to a site can adversely affect a site by preventing plant growth by acting as a physical barrier or even result in prolonged frozen soil conditions which in turn can affect vegetation growth. Mulch depth should not exceed 5cm. Too much mulch at a site can also become a fire hazard. For additional information and direction on how to manage wood chips on public land refer to ASRD's "*Management of Wood Chips on Public Land (2009)*" directive.

Figure 6. Mulch can be applied to a site after seeding.

Erosion Control Blankets

Steep slopes with slow re-vegetation and high erosion potential benefit from erosion control blankets (ECBs). ECBs are good for use in areas where flow velocity may wash out new vegetation. They also help vegetation establishment in grassy channels. Similar to mulching, they protect the soil from raindrop impact and compaction. They increase filtration, conserve soil moisture, and stabilize soil surfaces. They are often made of bio- or photo-degradable netting, and are classified as a Rolled Erosion Control Product (RECP).

It is important to use the correct product for your particular site. Additionally, blankets should be placed within 24 hours of seeding at your site. Additional information regarding ECBs is provided in Appendix B.

Figure 7: ECBs can be used to protect steep slopes.

Erosion Control Netting

Erosion control netting can be used where erosion control blankets are not suitable. For example, netting can be placed over loose mulch or freshly placed sod. It is important to be aware that erosion control netting may not be as effective as erosion control blankets.

Rock Outlet

A rock outlet is a protective device that is designed to control erosion at the downstream end of a channel or culvert. It is composed of rock, riprap, or concrete rubble and is placed at the outlet/downstream end. By reducing velocity of water flowing through the end of the channel, the rock outlet helps to decrease scour and downstream erosion. More information about rock outlets is provided in Appendix B.

Livestock and Land, 2010
http://www.livestockandland.org/Demonstration_Sites/pilot_site.html

Figure 8: Rock outlets can control erosion at the downstream end of a channel or a culvert.

A rock lining (or riprap) may also be used within a constructed ditch or a channel to protect the sides and bottom from erosion. The size of the rock use will depend on the flow and depth; however, rock should be laid to create a uniform surface to ensure that rock does not get displaced.

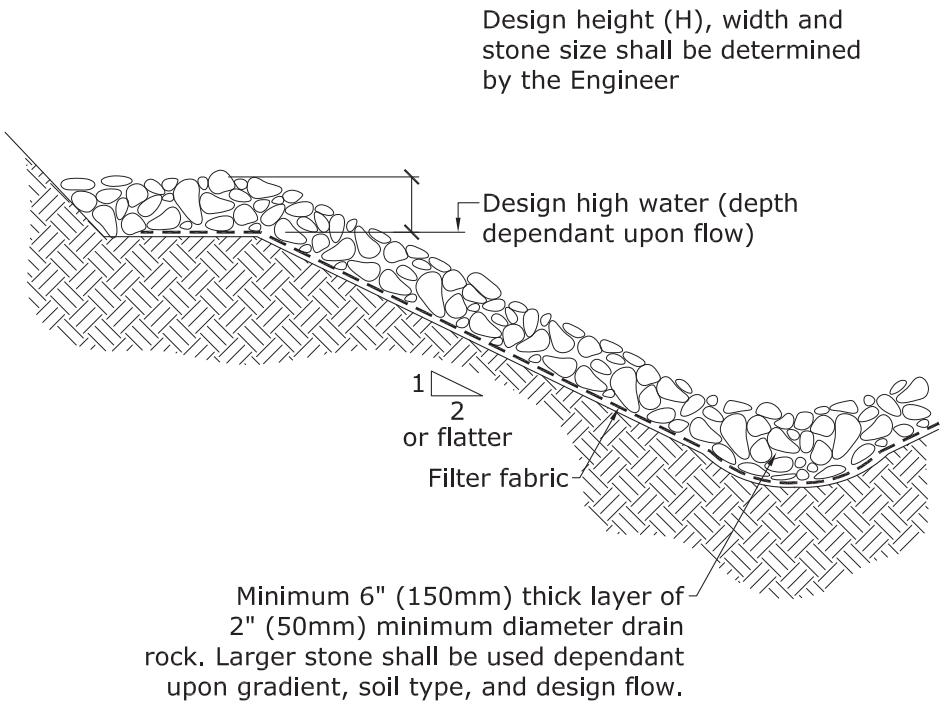

Design height (H), width and stone size shall be determined by the Engineer
Design high water (depth dependant upon flow)
1
2
or flatter
Filter fabric
Minimum 6" (150mm) thick layer of 2" (50mm) minimum diameter drain rock. Larger stone shall be used dependant upon gradient, soil type, and design flow.
McCullah 2000.

Figure 9: A uniform layer of rock can be used to prevent erosion within a constructed ditch or channel.

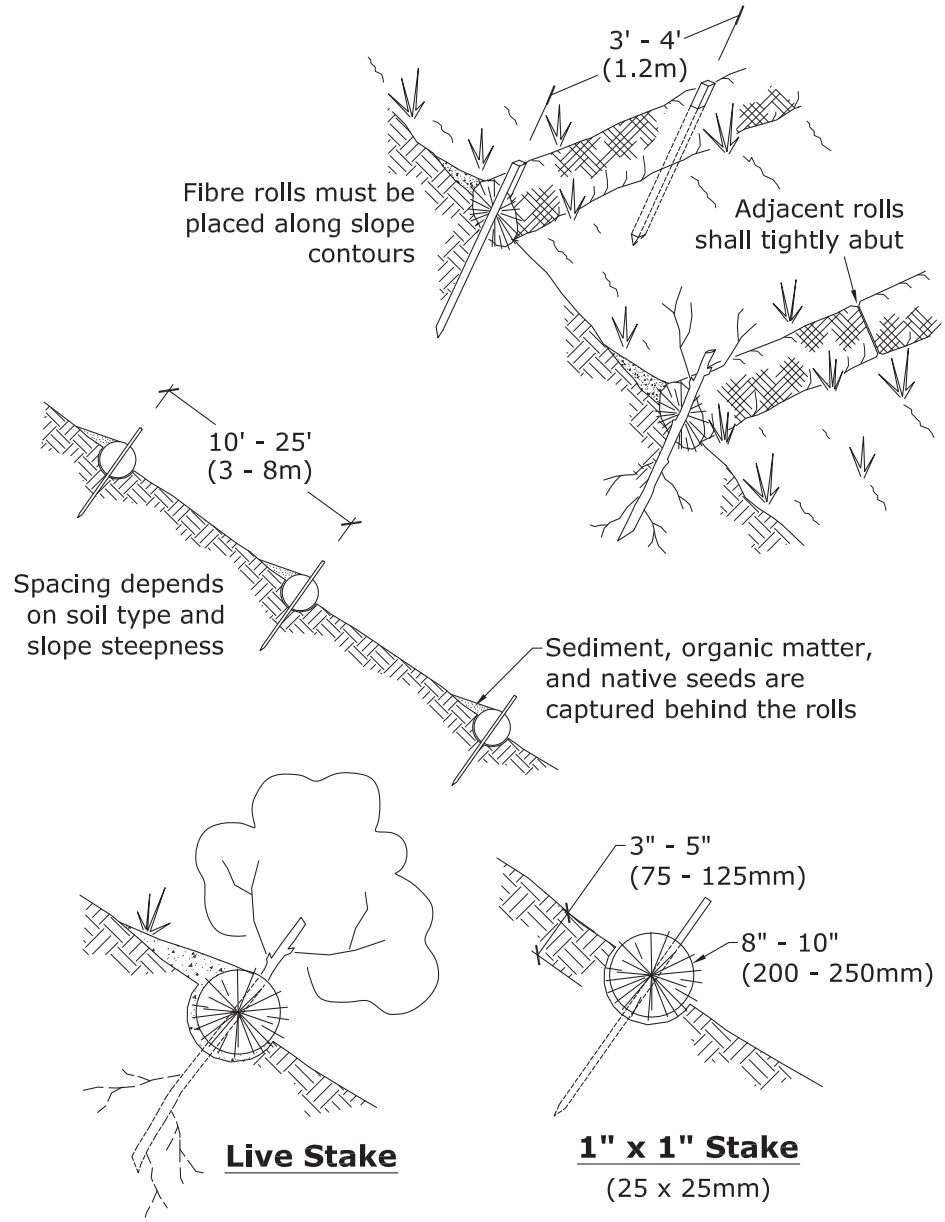
6.6.2 Sediment Control

Sedimentation is the deposition of soil particles previously held in suspension by a fluid, usually flowing water. Soil particles may be mobilized as water travels across bare soil, and then settle out as flow velocities subside. Sediment control involves any practice that settles or traps the soil particles after they have been detached and moved by wind or water. Sediment can be controlled at the source, through erosion prevention, or can be managed by capturing surface water in sediment basins, sediment traps, or other sediment control measures. The following BMPs are designed to control sediment.

Fibre Rolls

Fibre rolls consist of bundled sticks, or natural fibre, wrapped in photo-degradable open weave plastic netting that is staked into the soil along slope contours as a grade break. They are porous, allowing for capture of sediment, organic matter, and seeds carried by runoff.

Fibre rolls are a temporary measure against sedimentation to reduce conveyance of sediment by flowing water. They may be used on slopes that are stable enough to support vegetation. They may also be installed along long slopes as a grade break to shorten the slope length between lines of fibre rolls at different contour elevations. They also help to reduce overland flow velocities.


3' - 4'
(1.2m)
Fibre rolls must be placed along slope contours
Adjacent rolls shall tightly abut
10' - 25'
(3 - 8m)
Spacing depends on soil type and slope steepness
Sediment, organic matter, and native seeds are captured behind the rolls
3" - 5"
(75 - 125mm)
8" - 10"
(200 - 250mm)
Live Stake
1" x 1" Stake
(25 x 25mm)

McCullah 2000.

Note:
1. Straw roll installation requires the placement and secure staking of the roll in a trench, 3" - 5" (75 - 125mm) deep, dug on contour.

Figure 10: A fibre roll can temporarily reduce sedimentation.

Grass-Lined Swales

A grass-lined swale is constructed to handle concentrated runoff while preventing erosion and sedimentation. A grassed swale is vegetation lining placed in a ditch to stabilize a channel and protect it from erosion. Grass-lined channels are generally used in stable areas with slopes less than 15% in ephemeral drainages. Further details are provided in Appendix B.

Backyard Conservation, US Department of Agriculture Natural Resources Conservation Service, April 1998.

Figure 11: Grass-lined swales are used when concentrated runoff has the potential to c ause erosion.

Brush or Rock Filters

These are temporary barriers of brush wrapped in filter fabric and secured in place, or rock anchored in place, to intercept and filter sediment laden stormwater runoff from disturbed areas, retain sediment and release water as sheet flow. They are often used as a perimeter control and installed near the toe of slopes that are subjected to sheet flow and rill erosion. They are also installed along the crest or tops of stream and channel banks, as well as around drain inlets. They have the potential to be as effective as silt fences.

Check Dam

A check dam is a small, temporary dam that is constructed within a ditch or channel and is used to divert runoff to a desired location (Appendix B). The purpose of a check dam is to reduce the gradient of a ditch, thereby slowing the flow of water and reducing the potential for erosion and sedimentation. As water flow slows, sediment is more likely to settle out. Check dams are not suitable for natural watercourses, or any watercourse that contains fish as they may create a barrier to fish passage.

Figure 12: A check dam is a small, temporary dams constructed within a ditch or a constructed channel.

Sediment Basin

Sediment basins are sediment control measures that collect sediment run-off and promote settlement of sediment. They can be temporary or exist for the life of a project, and can be used at terminal or selective intermediate points of concentrated runoff. The basins result in impoundment of runoff and sedimentation of silt prior to release of treated runoff downstream. They are also used as control measures at the perimeter of sites, where sediment laden runoff may enter watercourses, storm drains, or other sensitive areas. Sediment basins are used for disturbed drainage areas greater than 2.0 ha. They must be periodically maintained to remove sediment, and larger basins are often equipped with forebays where coarse sediment settles out and where more frequent cleaning is required. By-product such as sediment fines may be reused during reclamation. Further information is provided in Appendix B.

Figure 13: Sediment basins collect run-off and promote settlement of sediment.

Sediment basins can be used to collect water from wash sites. Retention time will depend on the type and load of sediment being removed from the aggregate. Wash sites should be located within the pit excavation hole, in an area of natural water collection. These areas can provide settling areas for wash water as well as a collection basin for surface water. If the pit collects large amounts of surface water then two separate ponds can be created or the two areas can be separated by a berm. Using two ponds will reduce the amount of water accumulating at the bottom of the pit. Surface runoff will be less turbid than the wash water and will therefore require less time to settle.

Sediment Traps

Sediment traps are temporary devices used to contain sediment laden runoff, but they are smaller than sediment basins. They may be constructed by excavating ponds and/or placing embankments above grade. Sediment traps are used for disturbed drainage areas of 2.0 ha or less. They must also be periodically maintained to remove sediment.

Sediment Barriers

Sediment barriers are a barrier used to trap sediment from sheet flow runoff. They can be made using silt fences, straw bales, berms, inlet protection, etc. They are often used for areas with drainage of less than 2 ha. It is critical that sediment barriers be installed properly because, if not, they can worsen the situation by concentrating flows and causing erosion. As such, regular maintenance is required.

Silt Fences

Silt fences are permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff. They entrap and minimize coarse sediment from sheet flow or overland flow from entering waterbodies. If installed properly, they can be very effective at preventing sedimentation.

Water ponds behind silt fences, allowing sediment to settle out as water filters through fabric, therefore they should not be installed on a slope. Silt fences must be properly anchored in soil to prevent flow from being conveyed underneath, and should be placed in a "smile" or "J-hook" shape to allow water to be temporarily ponded behind the fence. Contributing drainage areas must be small enough that the ponded water can force flow through the silt fence without backing up far enough to outflank the fence or cause it to fail due to hydrostatic forces.

Figure 14: Silt fences are commonly used to prevent sedimentation.

Inlet Protection Measures

Inlet protection measures are considered the "last line of defence". They are a type of sediment trap consisting of a permeable barrier installed around a drainage inlet, to prevent or reduce sediment from leaving a work site. They are only appropriate on sites where underground drainage infrastructure has been installed, and may include drop inlet sediment barriers or catch basin inlet barriers.

Inlet protection measures should only be used in areas with a maximum drainage of 0.5 ha. Regular inspection, sediment removal and maintenance are required.

6.7 Pit Dewatering

Pit dewatering typically takes place in operations where the excavation is at, or below, the water table. Groundwater is the mandate of Alberta Environment. Authorizations to work below the groundwater table should be obtained from Alberta Environment.

Drainage within the pit can be maintained by sloping the pit bottom so that any excess water entering the pit through surface runoff or groundwater seepage can be collected at the deeper end. Settling ponds can be built within the excavation area to provide containment and settling time for any suspended solids within pit water. Settling ponds should be located away from any natural waterways or areas with high surface flows. All hazardous materials stored onsite should be stored away from settling ponds. Settling ponds should be constructed so that they are of an adequate size to handle the volume of water coming into the excavation.

Discharge of pit water may be required via natural drainage or discharging off-site through the use of pumps and pipes. The CRBP should contain any plans describing water conveyance around a site or plans to move water offsite. The "*Code of Practice for Pits*[41]" requires that pit water being discharged must be collected and analyzed for pH and total suspended solids. Presence of hydrocarbons such as oil and gas must also be assessed. It is important to retain copies of the analyses. Alberta Environment will dictate the type of sampling, frequency and location when a permit is obtained. For more information about working with groundwater, contact a local Alberta Environment representative.

The discharge of water offsite will require a Temporary Field Authorization (TFA) from ASRD. The lease holder is responsible for ensuring that their discharge will not cause adverse effects on any receiving waterbody.

6.8 Road Construction and Maintenance

Roads are an important part of site development. Roads are used to access sites, transport equipment to sites, and transport materials from sites. Roads can be temporary or permanent, based on the size of the operations and adjacent infrastructure. In many cases, road access is already available to a site, and an applicant may be required to obtain a permit to use the road. Applicants should attempt to use existing roads where feasible.

[41] AENV 2004

When new roads are to be constructed, applicants may be requested to present information regarding the proposed route and any alternate routes. Locations for access roads should be well designed to mitigate environmental concerns. Access roads should be maintained while they are in use. Regular maintenance through activities such as grading, ditch and culvert clearing and resurfacing can be mitigation for reducing an operation's environmental footprint. Road oiling must not occur.

The following are examples of BMPs for constructing and maintaining roads.

6.8.1 Construction

Planning

- Roads should be identified in the CRBP. Consider what type of road will be needed, how much traffic will use it and what kind of vehicles will use it. Unplanned road construction can result in higher maintenance and reconstruction costs.

Location

- Natural topography can be used to mitigate noise, dust and visual concerns. Natural topography can hide roads and eliminate any visual concerns.
- Locate roads on well-drained soil or soil with rocky surfaces away from streams, seeps, and other wet areas.
- When planning new roads, avoid water crossings, environmentally sensitive areas including areas with deeply erodible soils, steep slopes, and wetlands as much as possible. Similarly, areas with long slopes should be avoided as they can create problems with erosion that may be costly and time consuming to repair.
- Maintaining trees and vegetation along roadways provides visual barriers which can prevent the public from viewing inside the operation. Staggering or off-setting entrances to operations and curving entrance roads are techniques often used to prevent visual access into a site.

Timing

- Timing restrictions outlined for vegetation clearing and soil salvage should be observed.

6.8.2 Maintenance

Timing

- To avoid rutting and erosion, large trucks and heavy machinery should not use unpaved surfaces during wet periods. Restrictions may depend on type and conditions of road.
- Regularly spraying unpaved roads with water or dust retardant can reduce road dust where local residents identify this as an issue.
- Regular maintenance such as grading, ditch and culvert clearing and resurfacing can be mitigation for reducing the environmental footprint of the operation. Road oiling must not occur.

Speed limits

- Posting and enforcing reduced speed limits can help mitigate dust and noise.

Existing seismic lines or Licences of Occupation (LOCs) should be used for initial winter access. Any proposed widening of these areas should be minimized. Additional information concerning road development is available in the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[42]".

6.8.3 Watercourse Crossings

All watercourse crossings must follow the "*Code of Practice for Watercourse Crossings*[43]".

6.9 Hazardous Materials Management

Hazardous materials may be required onsite for the operation of a pit. Examples of hazardous materials include salt for winter road de-icing, oil, gas, diesel and paints. Any hazardous materials not directly related to the primary production of aggregate should not be kept on-site. Small operations may consider using onto site and offsite fuelling (i.e. slip tanks) to eliminate the need for storing any hazardous materials onsite. Any hazardous materials expected to be kept on-site should be identified in the CRBP.

The following BMPs can be used to improve the storage of hazardous materials on public land. Remember that it is the operator's responsibility to determine which of the BMPs presented in this document are appropriate for their site.

[42] ASRD 2007
[43] AENV 2000

Planning

- Plan ahead when purchasing material. Buy just enough required for the site to minimize storage of excess amounts of hazardous materials.
- Identify storage sites for hazardous materials in the CRBP. Ensure that all materials are stored in the designated sites.
- Label all drums clearly. MSDS sheets should be available for all hazardous materials.

Prevention

- Accidents can be minimized if storage sites are located away from high traffic areas and away from areas that may be exposed to high winds or rains.
- A smart BMP involves storing hazardous materials away from environmentally sensitive areas such as wetlands and drainage areas as well as drainage channels, settling ponds and quarry sumps.
- Hazardous materials storage areas should be kept at least a minimum of 100 metres away from any watercourse or waterbody.

Secondary Containment

- Storage sites should have an impermeable surface with a containment feature such as a dyke or barrier to prevent spills from contaminating groundwater or soil.
- Use drips pans and pails under machinery if drips are a problem.
- Allow adequate space between drums to allow for visual inspection.
- Storage locations should be fenced and locked.

Training

- Staff should be trained regarding proper material safety, storage, handling and disposal procedures.

6.10 By-Product Management

By-products are materials which are removed in order to access the merchantable aggregate. By-products can be a burden on-site as they may require additional space and handling if not removed. By-products produced at an aggregate operation may include:

- Clay;
- Oversized coarse rock;
- Overburden;
- Fine materials; and
- Stumps and woody debris.

Aggregate by-products do not pose a serious environmental concern, but if left unattended they can provide a safety risk and be visually displeasing. The amount of by-product produced at a site can be minimized by extracting and clearing only where necessary. Progressive reclamation is an excellent way to minimize storage needs for aggregate by-products. Alternative uses for aggregate by-product include:

- **Berms** - By-products such as overburden, clay, stumps and coarse rock can be used to create berms to manage noise and dust concerns. Position by-product stockpiles so that they act as noise and wind barriers.
- **Erosion and Sediment Control** - Large coarse rock can be used for erosion control on steep slopes or to create sediment traps.
- **Recontouring** – Grubbing materials, clay and overburden may be used for recontouring during reclamation.
- **Mulching** - Grubbing materials such as stumps and woody debris can be chipped and mulched for erosion control.
- **Sale** – Aggregate by-products may be sold if they have a commercial value.

By-product storage locations and disposal methods should be identified in the CRBP. If moving grubbing materials offsite, lease holders must work with ASRD representatives to determine timing restrictions related to Mountain Pine beetle or other pests. Hauling restrictions will apply.

Figure 15: Berms can act as barriers for wind and noise.

6.11 Noise, Dust and Visual Considerations

Noise and dust considerations trigger municipal requirements. Noise and dust are most typically a concern when a pit is located close to a populated area. Specific requirements applicable to a project are reviewed on a project by project basis[44] and may vary by municipality. Site specific information regarding noise and dust considerations is also required by the development of the CRBP. Further information is provided in the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[45]".

6.11.1 Noise

Noise is prevalent in all industrial operations. Noise intensity is measured in decibels and increases logarithmically, meaning that a small increase in intensity results in a much larger increase in loudness. When considering the possible effects of noise emissions on neighbours or wildlife, you must consider existing noise levels (if the area is already noisy, the threshold for noise may be higher), site location (vegetation may dampen noise), equipment (some equipment is quieter than others) and site layout and design (acoustic fences can be used for noise absorption).

[44] Alberta Transportation 2008

[45] ASRD 2007

Noise emissions during aggregate operations can result from a variety of activities, including:

- Processing and crushing of materials;
- Extraction and handling of materials;
- Grading;
- Conveying;
- Tree removal, grading, and topsoil and overburden handling;
- Loading;
- Stockpiling;
- Onsite transport truck; and
- Drilling and blasting.

Noise can be reduced or minimized with careful site planning and considering strategies such as source control, containment, site layout, timing, and interception. The following are examples of BMPs that can be used to mitigate noise concerns. Based on the location of the operation specific noise reducing practices may be required by the Municipality.

Planning

- Be aware of existing and future adjacent land use and how noise may affect them.
- Understand the principle receptors of the noise and how it may affect them

Location

- Noise generating activities, such a processing areas and haul roads, can be placed sheltered or naturally excavated hollows and low areas in the pit or quarry to reduce noise.
- Working faces can be oriented to deflect noise into less sensitive areas (i.e. away from the public).

Vegetation

- Vegetation can absorb noise. Maintaining trees, shrubs and ground cover can reduce noise emissions.

Berms and Barriers

- Use soil stockpiles in the construction of property line berms to assist in reducing noise levels.
- Buildings and stockpiles can be clustered to act as barriers for noise.

- Consider using portable barriers for specific operations such as drilling in preparation of a blast. Old conveyor belts can act as noise barriers.

Equipment

- Maintaining, lubing and repairing noisy equipment in a timely manner can reduce noise.
- It is best to shut off noisy equipment when not in use.
- Non-audible warning devices such as strobe lights or low frequency beepers are less noisy than other backup warning devices.
- Close tailgates on trucks to reduce unnecessary noise.
- Old conveyer belts can be used to line the interior of rock bins.

Drop Height

- Minimize the fall height of material during excavation and processing. Lowering drop height lowers the emission height, which could make use of shielding if noise is a serious concern onsite.

Traffic

- Use natural topography when designing haul routes. Natural topography can act as a barrier for noise.
- Limiting on-site speeds can reduce noise associated with bouncing trucks.
- Maintain smooth on-site roadways to eliminate ruts, a source of noise from on-site mobile equipment.

6.11.2 Dust

Dust can be caused by wind blowing over exposed surfaces as well as from aggregate extraction and processing. "Fugitive" dust is created when wind blows over stockpiles and/or areas that no longer have vegetation, as well as activities such as moving equipment. This dust often settles on nearby neighbours, and a common complaint from the public[46]. Because dust has the potential to travel far distances, reduction in dust emissions at the site can greatly improve air quality in the immediate vicinity and in the surrounding areas.

Fugitive dust can be generated from a number of activities and sources, including:

- on-site traffic especially unpaved roads;
- wind erosion from unprotected material stockpiles;
- loading/unloading areas and handling techniques;

[46] BC Ministry of Land and Water 2004

- material spills;
- material conveyance systems;
- drilling and blasting;
- exposed openings in process and storage buildings; and
- general work areas.

Fugitive dust is much easier to manage if all sources are identified up front. A dust map can be a useful tool for identifying all sources of high dust emissions and creating control actions. While dust is the most common air quality issue, there are other concerns including exhaust emissions from machinery and vehicles, and the noise concerns mentioned in Section 6.11.1 to be considered. The following are examples of BMPs that can assist with fugitive dust concerns.

Planning

- Identify all dust generating activities such as haul roads and processing locations up-front and attempt to position those activities in sheltered low-lying areas that are protected from the wind. Stockpiles, buildings and onsite vegetation can act as wind breaks.
- In areas where dust is a concern identifying all dust suppression best management practices up front as well as who is responsible for implementation can help prevent dust problems from occurring.

Location

- Locate haul roads and processing areas down wind from sites that will be sensitive to dust.

Equipment

- Maintain bins, chutes and receiving hoppers clean and in good condition to reduce unnecessary dust.

Traffic

- Locate roads downwind from areas that may be sensitive to dust. This will reduce the amount of dust blowing into those areas.
- Where possible flush or sweeper trucks, spray nozzles, and wheel washers may be used to prevent or mitigate fugitive dust emissions from roads.
- Limiting traffic speeds on roads can reduce the amount of dust created by traffic.

- Placing tarps on loads, where possible, can reduce spills.
- Soil Stockpile Management
- General soil stockpile management BMP's such as location, seeding, and contouring can be used to reduce fugitive dust.

Wet Suppression

- Wet suppression techniques such as the use of water spray nozzles to add moisture to the soil or to capture and suppress dust with a fine spray can be used to control and minimize dust emissions
- Watering systems can be permanently mounted on the inlet and outlet points of all crushers, on the outlet of all shaker screens, and on the outlet of all material transfer points.
- Direct the wastewater generated from wet suppression towards containment areas or the wash out basins where it can be recycled into the concrete or used again for dust suppression.

Weather

- In areas where dust is a consideration, monitor weather conditions to manage neighbouring impacts. Manage activities on windy days.

6.11.3 Visual Considerations

Public lands are used by both the public for recreational purposes, and industry to extract the resources necessary for development of infrastructure across Alberta. Managing for visual considerations is important for maintaining an aesthetic balance between those who use public land for industry and those using them for other purposes. Public lands host numerous recreational activities where visual aesthetics can be a concern. Visual impacts can be reduced by careful site planning, and consultation with neighbours and the public. Municipalities should be contacted to ensure that the proposed operation is in line with land-use plans, ordinances and by-laws. The following BMPs are examples of practices that have been applied to reduce visual considerations.

Planning

- Understand current and future uses of the land and design the operation to reduce visual impacts.

Location

- Pits and quarries can be positioned to limit visibility into the operation. Use natural topography and maintain onsite vegetation to restrict views.

- Maintaining the scale of the operation at the level of the surrounding topography will reduce the visual impacts.
- Activities can be clustered around natural barriers to reduce the area of disturbance.

Progressive Reclamation

- Phase extraction to limit the area of disturbance. Progressive reclamation must be used to quickly restore areas where extraction has occurred.

Traffic

- Haul roads can be designed with curves and stagger entrances to prevent visibility into the site.
- Haul roads can be constructed in lower-lying areas or concealed by berms and barriers such as natural vegetation or topography.

Vegetation

- Vegetation should be maintained around the perimeter on the lease area, where feasible, to minimize views into the site.

6.12 Pit Closure

After extraction has occurred lease holders are required to close the pit and begin reclamation. This final stage prior to reclamation should not require much effort if the following principles were applied throughout the operation:

- **Maintenance** – Ongoing maintenance is required to manage onsite vegetation, healthy soil stockpiles, weed control, erosion and sediment, hazardous materials and by-products. The BMPs provided in this document are designed to provide ongoing maintenance of common environmental considerations throughout the life of a pit.
- **Progressive Reclamation** - The closure of the pit should be incorporated into the progressive reclamation plan. If progressive reclamation has been applied successfully throughout the life of a pit then, depending on the size and type of the operation, seeded and natural vegetation should be in the process of establishing. Natural processes, such as surface drainage will ideally begin function within the reclaimed areas.

Once initial reclamation is underway, a site clean-up should occur where all remaining debris and garbage is removed from the site[47]. Reclamation is not complete until the site is completely cleaned of all debris. Natural extraction by-products which were not buried in the pit (Section 6.10)

[47] Green et al 1992

should be disposed of offsite. No non-native materials should be buried onsite. Weed control is an important consideration and weeds must be controlled onsite prior to closing the pit.

All hazardous materials and equipment must be removed from the site.

Under the *Public Lands Act*, the liability of an SML remains in effect until the disposition holder has obtained a Reclamation Certificate from ASRD. The lease holder must provide sufficient documentation to verify that all conditions outlined in the CRBP, including the reclamation plan, have been met. Documentation must also indicate that

a. All improvements have been removed from the site;

b. All brush and by-product materials have been disposed of; and

c. Reclamation is complete and vegetation is established onsite.

A Reclamation certificate will be issued once the conditions outlined in the CRBP have been met and the site is inspected and approved by an ASRD representative. As outlined in the Conservation and Reclamation Regulation under the EPEA, the lease holder remains liable for reclamation issues that arise onsite for five years after the Reclamation Certificate has been issued. The Reclamation Certification process is further outlined in the "*Guidelines for Acquiring Surface Material Dispositions on Public Land*[48]".

[48] ASRD 2007

7 Monitoring BMPs

The application of a BMP does not guarantee that the concern will be mitigated. BMPs require monitoring to determine whether they are functioning as required and in many instances BMPs require monitoring to remain effective. The success of a BMP will be site specific and their success may depend on the geographical location, local climate, soil type, slopes or the season. The schedule for monitoring the BMP will be determined by the type of BMP and the consequences of failure[49]. For example, many erosion and sediment control BMPs require inspection immediately after large storm events and therefore, the frequency of monitoring events will be higher during the rainy season than the dry season. Seeded stockpiles on the other hand, may only require monitoring initially to determine whether plants are establishing and periodic monitoring to ensure that soil is not being eroded by wind or water.

BMP monitoring can occur during the facility's regular working hours. In some instances, BMP monitoring will be required by the law and will be outlined in permits, authorizations and approvals issues by various levels of government. Holders are encouraged to work with an ASRD representative to determine which BMPs are functioning onsite and where changes should be made.

[49] BC Energy and Mines 2007

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9 Glossary

A Horizon: A mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension, or maximum in situ accumulation of organic carbon or both.

Aggregate: A composition of different surface materials.

B Horizon: The B horizon, commonly referred to as subsoil, consists of mineral layers which contain concentrations of clay or minerals such as iron or aluminum, or organic material which leach from the surface. The B horizon differs from the A horizon in structure and consistency.

Best management practices: These are non-regulatory management, and operational practices that should allow the operator to not only meet the required standards, but also prevent, or mitigate, any undesirable effects or unforeseen complications associated with sand and gravel mining.

Benching: A bench is a relatively deep, permanent cut in a steep backslope. Benches are constructed for safety, stability, drainage. They can reduce erosion by reducing the length and steepness of the slope, therefore reducing the velocity of the water flowing down the slope.

Berm: A constructed barrier of overburden, topsoil or waste rock, often planted with trees, shrubs and ground cover. Berms can be used to block noise, dust and views of an aggregate operation.

Check dam: A small, temporary or permanent, dam which is a built across a natural drainage channel or a drainage ditch. It can reduce erosion by lowering the velocity of the water flow during storm events, allowing sediment to settle out of stormwater.

Compaction: Occurs when wet soil is piled, or if weight is placed on the soil which causes it to lose pore space. Compacted soils are less able to absorb rainfall, and are more susceptible to erosion. Plants have difficulty establishing in compacted soil as there is little space for air and water between the soils. Soil can become compacted during stockpiling or replacement.

Culvert: A conduit (e.g., pipe) used to transport water through an embankment.

Disposition: A disposition is the authority granted by the department to use public land for specific purposes and activities. A disposition is any instrument executed pursuant to the Public Lands Act and includes conveyance, assurance, sale, lease, licence, permit, contract or agreement. Details regarding specific disposition types can be found in the Dispositions and Fees Regulation under the Public Lands Act.

Ditch: A long and narrow channel dug into the earth where drainage often occurs.

Erosion: The wearing away of a ground surface as a result of wind, water or ice.

Erosion and sediment control: Measures that are undertaken to reduce or prevent erosion and control sedimentation. They may be temporary or permanent.

Face: The exposed unbroken rock of the quarry after a blast has taken place.

Forb: Any herb that is not a grass.

Fugitive dust: Dust that is created when wind blows over areas that no longer have vegetation, as well as by moving equipment. This dust often settles on or around nearby neighbours.

Grading: Any activity that disturbs the earth. This can include excavation, cutting, filling, and/or stockpiling.

Groundwater: Water located beneath the ground surface in soil pores and spaces, and between fractures in rock. Alberta Environment is responsible for managing groundwater.

Grubbing: Removing vegetative matter, such as stumps, roots or brush.

Guideline: A course of action that is suggested but is not legislation/ regulation.

HADD: Harmful alteration, disruption or destruction of fish habitat.

Impoundment: An area where surface water is held/contained. It can be manmade or natural.

Licence: Means a surface material licence.

Mitigation measure: An action undertaken during any aggregate operations, including the planning stage, that prevents impacts such as erosion, sedimentation, HADD, etc.

Mulching: The application of organic material or other normally biodegradable substances as a protective layer to the soil surface. It helps to minimize raindrop/runoff erosion and conserve soil moisture for plant growth, as well as promote seed germination and plant growth.

Operations: Means the clearing, stripping, excavating, processing and removal of surface material from, and the reclamation of, public land described in a lease or licence.

Overburden: Unconsolidated material overlying the rock or sand and gravel to be extracted, excluding the economically valuable sand and gravel layers. Overburden is typically poorer quality material and must be removed to extract economically valuable horizons.

Reclamation: A recovery process whereby a disturbed area is returned to a state that is similar to the original.

Revegetation: The re-establishment of self-sustaining plant cover on a disturbed site.

Rill: A very small and intermittent watercourse. It has steep sides and is usually only a few inches deep. They are often a result of increased surface water flow when soil is cleared of vegetation.

Riparian zone: The boundary between land and a waterbody often thought of as the land bordering the high-water mark. These areas have very diverse vegetation, resulting from the relatively predictable but intermittent influence of the surface water.

Sediment: Material that is a result of erosion and weather of rocks or unconsolidated deposits.

Sedimentation: The deposition of soil particles previously held in suspension by a fluid, usually flowing water. Sedimentation can alter fish habitat as it settles into interstitial spaces.

Sediment barriers: A barrier used to trap sediment from sheet flow runoff. They can be made using silt fences, straw bales, berms, etc.

Sediment basin: A sediment control measure that collects sediment run-off and promotes settlement of sediment. They can be temporary, or exist for the life of the project, but must be maintained. They are for use in areas with drainage greater than 2.0 ha.

Sediment trap: A temporary device used to trap sediment laden runoff, but smaller than sediment basins. They must be maintained. They are for use in areas with drainage less than 2 ha.

Seedbank: The organic layer on the surface of soils is a valuable source of native seed, rhizomes and bulbs that can be salvaged and used to "seed" reclaimed areas. It is a quick and cost-effective method for re-establishing a native plant community.

Silt fence: A temporary sediment control device that is used to prevent sediment from entering a nearby waterbody or watercourse. They are permeable fabric barriers installed vertically on support posts along contours to collect and/or filter sediment laden sheet flow runoff.

Stripping: Removing topsoil and debris from above a mineral soil.

Stormwater: Water that originates as a result of precipitation. Stormwater may soak into the ground, or become surface runoff. The amount of surface water increases as the amount of natural groundcover decreases.

Subgrade: Is the native material underneath a constructed area such as a road or railway.

Subsoil: The subsoil, or B horizon, is a mineral layer which is formed as minerals are leached from the topsoil layer. Subsoil is located beneath the topsoil but above the overburden or bedrock. Plant roots may penetrate through this layer; however, it is much less productive but much deeper than the topsoil. Subsoil is typically brownish or red in colour because of the lay and iron oxides that wash down from the topsoil layer. In the southern part of Alberta, subsoil can vary in colour and is often indistinguishable from the topsoil (see below) layer in colour.

Surface Material: Means clay, marl, sand, gravel, topsoil, silt

Topsoil: Topsoil, also known as the A horizon, is the most fertile portion of the soil. The difference between the topsoil and the subsoil, or the B horizon, is commonly described by the colour and the texture. The topsoil is usually darker and contains more organic matter, or it may be lighter and contain less clay than the deeper subsoil. Topsoil is much more fertile than the less productive subsoil, and is critical for re-establishing the ecosystem structure of the reclaimed site.

Wastewater: Water that contains foreign agents as a result of human activities.

Waterbody: Natural or artificial surface water, including lakes, wetlands, streams and rivers.

Watercourse: A channel that caries water, either continuously or intermittently.

Appendix A

Government Contact Information

Government Agency	Act	Contact Information
Fisheries and Oceans Canada	*Fisheries Act*	*Fisheries and Oceans Canada – Central and Arctic Office* 520 Exmouth Street Sarnia, Ontario N7T 8B1 Toll Free: 1.866.290.3731 Fax: 519.464.5128 *Fisheries and Oceans Canada – Alberta Districts* Calgary Office: 403.292.5160 Edmonton Office: 780.495.4220 Lethbridge Office: 403.394.2920 Peace River Office: 780.618.3220 www.dfo-mpo.gc.ca/regions/central/contact/index-eng.htm
Canadian Wildlife Service – Environment Canada	*Migratory Birds Convention Act, 1994* *Species at Risk Act* *Canadian Environmental Assessment Act*	*Environment Canada – Alberta Office* 4999 98 Avenue, Room 200 Edmonton, Alberta T6B 2X3 Tel: 780.951.8600 Fax: 780.495.2615
Transport Canada	*Navigable Waters Protection Act*	

Government Agency	Act	Contact Information
Alberta Sustainable Resources Development	*Public Lands Act* *Forests Act* *Alberta Wildlife Act* *Alberta Land Stewardship Act* *Forest and Prairie Protection Act* *Mines and Minerals Ac*	*Alberta Sustainable Resource Development* Main Floor, Great West Life Building 9920 108 Street Edmonton, Alberta T5K 2M4 Tel (Edmonton): 780.944.0313 Toll Free: 1.877.944.0313 Fax: 780.427.4407 Email: srd.infocent@gov.ab.ca www.srd.alberta.ca
Alberta Environment	*Water Act* *Environmental Protection and Enhancement Act* Pesticide Regulations Code of Practice for Pits Code of Practice for Watercourse Crossings Conservation and Reclamation Regulations	*Alberta Environment* Information Centre Main Floor, 9820 – 106 St. Edmonton, Alberta T5K 2J6 Tel (Edmonton): 780.427.2700 Toll free: 310.0000 Fax: 780.422.4086 www.environment.alberta.ca
Alberta Agriculture and Rural Development	*Weed Act*	*Alberta Agriculture and Rural Development* 100A J.G. O'Donoghue Building 7000 113th Street Edmonton, Alberta T6X 5T6 Tel (Edmonton): 780.427.2727 Toll Free: 310.3276 Email: duke@gov.ab.ca
Alberta Culture and Community Spirit	*Historical Resources Act*	*Alberta Culture and Community Spirit* 418 Legislature Building 10800 97 Avenue Edmonton, Alberta T5K 2B6 Tel (Edmonton): 780-422-3559 Fax: 780-427-7729 Email: CCS.Minister@gov.ab.ca
Alberta Natural Heritage Information Centre	The Alberta Natural Heritage Information Centre tracks sensitive species information.	*Alberta Tourism, Parks and Recreation* 2nd Floor, Oxbridge Place 9820 - 106 Street Edmonton, Alberta, Canada T5K 2J6 Tel (Edmonton): (780) 427-5209 Fax: (780) 427-5980

Appendix B

BMP Fact Sheets

Applying Mulch on Public Land

Purpose

Mulching is the application of woody material to the soil surface to help increase filtration and protect soils from raindrop impact (Figure 1). It will also help to prevent or reduce erosion, conserve moisture, prevent soil compaction, and decrease runoff. Mulch can be placed over soil where seeding has recently occurred to prevent seed from blowing or washing away, insulate the soil, protect seed from predators, etc., helping to establish vegetation. Mulching is a temporary erosion and sedimentation control measure.

Beneficial use of wood chips includes:

- Reduction of industrial footprint; and
- Erosion control and protection of the soil resource.

Figure 1: Compost mulch applied to the soil surface.

Design Considerations

Mulch can be applied wherever soil has been disturbed and the vegetative layer has been removed. It is suitable on slopes where rill erosion may occur, but should not be used on slopes steeper than 3:1 (horizontal:vertical). If the purpose of mulching is to establish vegetation, they should last as long as it takes vegetation to properly establish.

When placed on steep slopes, mulch should be anchored (disking, crimping, studded rollers, etc.) or applied hydraulically.

Types of mulching include:

- Erosion control blankets;
- Wood chips or bark; and
- Hydraulic mulches from wood and/or wood and paper fibre.

Erosion control blankets are suitable for post-construction site stabilization, and stabilization of soils on steep slopes. They can also be used in channels where velocity may wash out new vegetation. Seeding should occur before blankets are installed, and other erosion control vegetation can be installed afterwards.

Wood chips or bark should be used at a depth no thicker of 5cm to prevent soil nutrient concentration being depressed under the layer of bark. Where there is excessive >5 cm wood chips accumulation, it must be documented and a rationale must be provided. Documentation

must indicate how any potentially negative effects on soil thermal properties and/or vegetation establishment have been addressed.

Wood chips shall not be spread on tame pasture and native rangelands such as native grasslands, forests and riparian areas[1].

Maintenance

If properly installed and anchored, little maintenance is required. After rain events or periods of high wind, maintenance is required to ensure that cover is still adequate. Re-mulching should occur immediately, if necessary.

Erosion control blankets can last up to two years, while mulch can last from six months to three years.

[1] Alberta Sustainable Resource Development. 2009. Management of Wood Chips on Public Land. External Directive

Sources

Alberta Sustainable Resource Development. 2009. Management of Wood Chips on Public Land. External Directive.

City of Edmonton. 2005. Erosion and Sedimentation Control Field Manual. <http://edmonton.ca/city_government/documents/FieldManual.pdf>, June 2010.

Idaho Department of Water Quality. 2005. BMP 15: Mulching. IDEQ Storm Water Best Management Practices Catalogue. <http://www.deq.state.id.us/water/data_reports/storm_water/catalog/sec_2/bmps/15.pdf>, June 2010.

McCullah, J., CPESC. 1993. North Carolina Erosion and Sediment Control Planning and Design Manual; Association of Bay Area Governments, Manual of Standards for Erosion and Sediment Control Measures; California Storm Water Best Management Practices Handbook.

Alberta Sustainable Resource Development

Brush Barrier

Purpose

A brush barrier is a temporary sediment control measure that is applied at the perimeter of a site (Figure 1). It consists of vegetative material or other debris that is left over after clearing and grubbing the site. Brush barriers allow runoff to continue to flow while retaining sediment.

Design Considerations

Brush barriers should be approximately 1 m tall and 1.5 m wide at the base. The barrier should be imbedded 10 cm into the soil, and a trench that is also 10 cm deep and 15 cm wide should be dug on the upstream side of the barrier. The vegetative material used to create the barrier should then be covered with geotextile or fibre cloth to stabilize the structure. The fabric should be placed within the trench, covered with soil, and compacted. Ensure that the fabric is sufficiently staked down on the downstream side of the barrier.

US Environmental Protection Agency, 2008.

Figure 1: A brush barrier, designed to trap sediment from runoff.

Individual pieces of material used to construct the brush barrier should be no greater than 15 cm wide. Larger material will create gaps in the barrier, allowing sediment to flow through with the runoff.

Brush barrier drainage areas should be no greater than 0.25 acres per 30 m of barrier length. The slope leading to the barrier must be 2:1 or less, and no longer than 30 m.

Other Considerations

Brush barriers are only suitable for low-velocity areas where flow is less than 0.03 m3/s. They are not suitable for concentrated flow.

If clearing and grubbing the site does not result in enough vegetative material needed to construct a brush barrier, alternative sedimentation control methods must be implemented (e.g., silt fence).

Maintenance

Brush barriers must be inspected after runoff or rain events. If channels form through gaps in the barrier, the gaps must be eliminated. Sediment accumulating on the uphill side of the barrier must be removed when it reaches 2/3 the height of the barrier. When the site has been fully stabilized, the barrier must be removed and properly disposed of.

Sources

McCullah, J., CPESC. 1993. North Carolina Erosion and Sediment Control Planning and Design Manual; Association of Bay Area Governments, Manual of Standards for Erosion and Sediment Control Measures; California Storm Water Best Management Practices Handbook.

US Environmental Protection Agency. 2008. Brush Barrier. National Pollutant Discharge Elimination System (NPDES). <http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=55>, June 2010.

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Buffer Zone

Purpose

A buffer zone is a natural or planted vegetated strip maintained adjacent to a shoreline, wetland or stream, as well as pit operations. The purpose of a buffer is to reduce erosion and sedimentation by maintaining bank stabilization, reduce noise, block wind, maintain a travel corridor for wildlife and improve the visual appearance of a site. Vegetation along a waterway will filter out pollutants or sediment that may be collected in surface runoff as it travels across a site. The buffer zone will also help prevent loss of soil material that could be suitable for reclamation purposes.

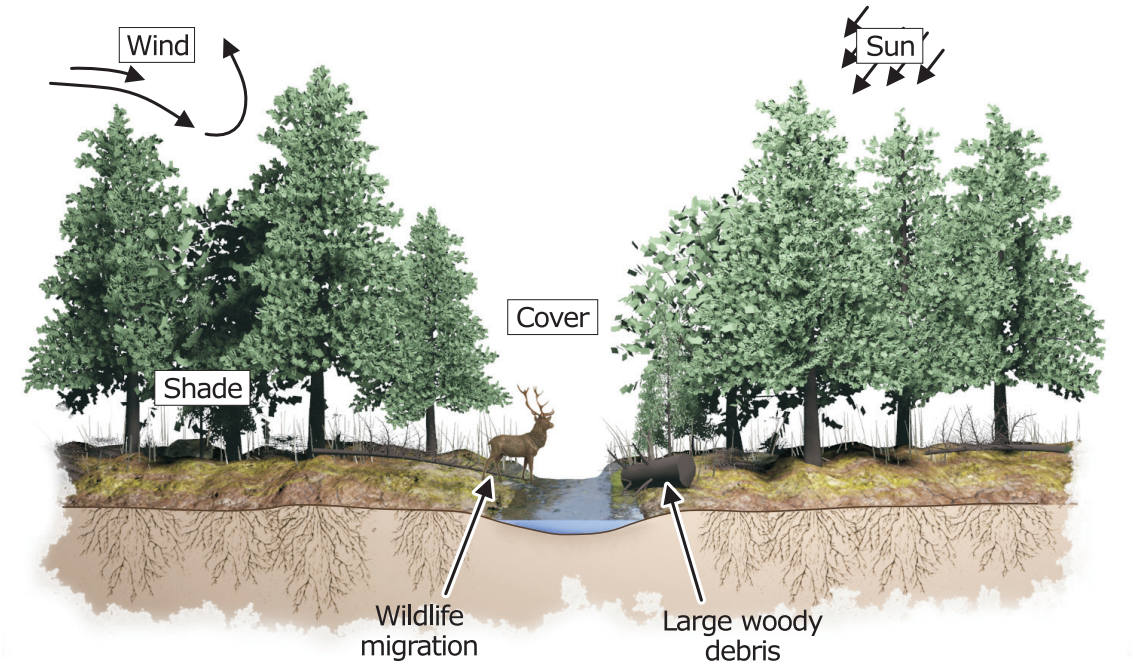

Figure 1: Natural buffers around waterways provide stream bank stabilization, prevent erosion, filter pollutants, provide wildlife habitat and shade streams.

Design Considerations

The following land and resource management factors are often associated with buffer width:

Timber Types – Less stable vegetation requires wider buffers to avoid blow-downs.

Wildlife Use – Riparian areas can act as important wildlife corridors.

Slope – Areas with higher slopes may require wider buffers.

Soil Types – As the soil becomes more compact, the infiltration rate is reduced thereby reducing the retention rate of water within the buffer. A wider buffer zone is required with increased soil compaction.

Aquatic Areas – Sensitivity of the watershed including flooding potential, watercourse characteristics (i.e. sinuosity), type of fishery and fish habitat will dictate the size of the buffer.

Existing Vegetation Types – Some vegetation types are more effective buffer (see table 1).

Aesthetics and Recreation Use – Buffers can be used to create a visual barrier.

Depending on the benefit that is desired by retaining a buffer zone, different vegetation types are suitable (Table 1).

Table 1. Relative effectiveness of different vegetation types for providing specific benefits (NRCS Planning & Design Manual 1994).

Benefit	Vegetation Type		
	Grass	Shrub	Tree
Stabilize bank erosion	Low	High	High
Filter sediment	High	Low	Low
Filter nutrients, pesticides, microbes			
• Sediment bound	High	Low	Low
• Soluble	Medium	Low	Medium
Aquatic habitat	Low	Medium	High
Wildlife habitat			
• Range/pasture/prairie wildlife	High	Medium	Low
	Low	Medium	High
Economic products	Medium	Low	Medium
Visual diversity	Low	Medium	High
Flood protection	Low	Medium	High

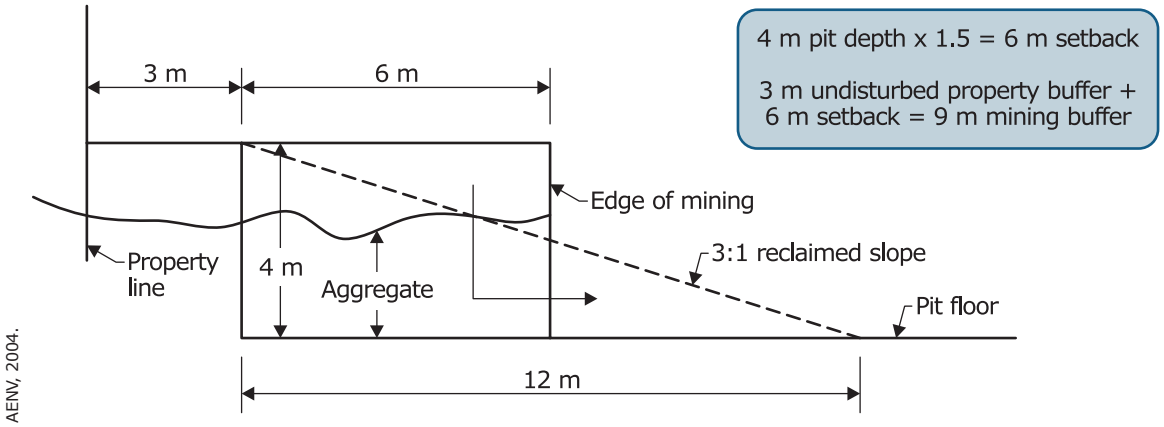

Figure 2: Extraction setback example.

- It is important the ensure that runoff from a disturbed area is distributed throughout the entire buffer zone, not concentrated in a single discharge point within a buffer zone.
- If a natural buffer zone is not available, alternatives include installing flow barriers, diversions, sediment traps, vegetative planting or silt fences.
- Buffers along pit operations, e.g., between operations and a roadway, should be at minimum 3 m wide.
- Natural buffers around sensitive areas such as waterways and wetlands should always be maintained.

Extraction Setbacks

The setback width must be added to the buffer zone width. There must be enough room and material available to meet sloping requirements for the excavation. For example:

- The extraction setback should be equal to the average depth of the pit multiplied by 1.5 for property boundaries where a 3:1 slope is to be established (see Figure 2). This allows for maximum resource development while maintaining a stable slope that can be revegetated with relative ease.
- For a pit with an average depth of 4 m, the extraction setback would be 4 m x 1.5 = six metres.
- The distance from the actual property boundary to where the mining must stop would be 3 m (recommended undisturbed buffer adjacent to the property line) plus 6 m (extraction setback) = 9 m.
- During reclamation, the material left in this extraction setback is used to establish a 3:1 slope starting from the edge of the three metre undisturbed buffer and running to the pit floor.
- Extraction setback distances must be increased in cases where flatter slopes are needed adjacent to the buffer zone.
- It is important to ensure that there are no stability problems at the pit face. Extraction can occur in the setback area if overburden material can be used to stabilize the slope and ensure stability.

Maintenance

Natural buffer zones require little maintenance, however, they should be inspected after rain or runoff events to determine if large amounts of sediment have been deposited. If erosion channels are developing, they should be repaired immediately.

Planted vegetation may need to be watered until they are well established. Pruning will also help to promote thick and sturdy plant growth.

Sources

Alberta Environment. 2004. A Guide to the Code of Practice for Pits. <http://environment.gov.ab.ca/info/library/5997.pdf>, June 2010.

British Columbia Ministry of Energy and Mines. 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Volume II: Best Management Practices.

Government of Alberta Agriculture and Rural Development. 2010. Buffer Zones for a Healthy Watershed. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr6419>, June 2010.

US Department of Agriculture, Natural Resources Conservation Service. 1994. Planning and Design Manual for the Control of Erosion, Sediment and Stormwater.

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Sustainable Resource Development

Check Dam

Purpose

A check dam is a small, temporary dam that is constructed within a ditch or channel and is used to divert runoff to a desired location (Figure 1). The purpose of a check dam is to reduce the gradient of a ditch, thereby slowing the flow of water and reducing the potential for erosion and sedimentation. As water flow slows, sediment is more likely to settle out. Check dams are not suitable for natural watercourses, or any watercourse that contains fish as they may create a barrier to fish passage.

Figure 1. Check dams situated within a ditch.

Design Considerations

Check dams should only be used in areas where drainage is less than 1 ha and channel slopes are less than 10%.

If water will flow rapidly over the dam, use gravel, cobble, etc. that is non-erodible for construction. For dams where granular material is suitable, ensure that the dam has a triangular cross section with a 2:1 slope (horizontal to vertical).

Maximum height of the dam should be 0.6 m, with a 0.25 m notch in the centre that will help control the flow. The top of the dam should be 0.3 m below the top of the ditch.

When constructing multiple dams, the toe of the upstream dam should be at the same elevation of the top of the downstream dam. Table 1 provides guidelines for spacing in between check dams.

Table 1: Guideline for spacing in between check dams, based on slope grade (City of Edmonton).

Slope Grade (%)	Maximum Length (m)
2	30
4	23
6	15
8	12
10	7.5

Boards or straw bales may be used in dam construction as well. If using these materials, install rip rap below the outfall to help prevent erosion.

Check Dam Options

Filter Fabric: this can be placed under a rock or sandbag check dam, anchored in a trench. It helps prevent sediment from flowing through the damn.

Straw Bale Check Dam: can be used in minor swales and ditches. Drainage must be less than 1 ha, or the dam must be pulled out in 2 months.

Log Check Dam: composed of boards or logs, embedded at least 0.5 m in the soil and extending 4 to 6 inches out of the soil.

Maintenance

If flows that are heavily laden with sediment are expected, inspection of the dam should occur regularly (during and after). Areas with deposition should be cleaned out and repaired when necessary.

Deposition will likely occur above the dam, and erosion will occur below the damn.

Remove sediment once it reaches half of the height of the dam.

Sources

British Columbia Ministry of Energy and Mines. 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Volume II: Best Management Practices.

City of Edmonton. 2005. Erosion and Sedimentation Control Field Manual. <http://edmonton.ca/city_government/documents/FieldManual.pdf>, June 2010.

McCullah, J., CPESC. 1993. North Carolina Erosion and Sediment Control Planning and Design Manual; Association of Bay Area Governments, Manual of Standards for Erosion and Sediment Control Measures; California Storm Water Best Management Practices Handbook.

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Erosion Control Blanket

Purpose

Erosion control blankets are a temporary blanket that is placed on top of areas that are susceptible to erosion (e.g., often bare exposed soils) and areas where vegetation is slow to establish (Figure 1). They help to stabilize the soil, prevent seed from washing away, increase infiltration, protect soil from impact of raindrops, and conserve moisture. They are often used on steep slopes where the erosion potential is very high and in channels where flow has the potential to wash out new vegetation.

When the growing season is short and plants may have difficulty establishing, erosion control blankets are recommended over hydro-seeding.

Allied Landscape and Contractor Supply. 2010. Erosion Control. http://www.alliedlandscape.com/erosion_control.html, March 2010.

Figure 1: Erosion control blankets help to stabilize soil, prevent loss of seed, increase infiltrations, etc.

Installation Considerations

It is very important to follow the directions for the product you are using and not to cut corners. The following directions may not be appropriate for all products.

Erosion control blankets should be placed within 24 hours of seeding the area.

Proper anchoring is important. If rills or gullies develop underneath the blanket, the effectiveness of the blanket is severely reduced. At the top of the slope, the blanket should be anchored 150 mm deep, backfilled, and compacted.

The blanket should be unrolled in the direction of water flow. The ends must overlap 180mm and the edges must overlap 100 mm. They must be stapled every 900 mm.

If blankets are laid similarly to shingles, they must overlap 180 mm and also be stapled every 900 mm[1].

[1] City of Edmonton. 2005.

Maintenance

Erosion control blankets must be maintained regularly, especially after storms and runoff events. Blankets can mask slope failures therefore close inspection is required. Loose sections should also be restored.

Additional Information

Erosion control blankets are used in areas where they are needed for up to two years. They are often made of wood fibre, mulch or synthetic materials and will eventually degrade over time, leaving behind only the established vegetation.

Sources

British Columbia Ministry of Energy and Mines. 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Volume II: Best Management Practices.

City of Edmonton. 2005. Erosion and Sedimentation Control Field Manual. http://edmonton.ca/city_government/documents/FieldManual.pdf, June 2010.

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Grading

Purpose

Grading is reshaping of the ground surface to prepare the land for any upcoming activities (Figure 1). It provides a suitable topography for extraction activities. Grading is often necessary for operation of equipment and stockpiling, to control surface runoff and to minimize erosion and sedimentation.

Figure 1: Grading of the ground surface to prepare for equipment operation and stockpiling.

Design Considerations

Careful design and planning of the site can help reduce erosion, and therefore reduce the cost of implementing erosion control measures. In fact, appropriate grading can form the basis of an erosion and sedimentation control plan.

A grading plan should include/consider the following:

- Which slopes require grading;
- The desired slope angle;
- The length of the finished graded area;
- Where excavated material will be stored; and
- When/where borrow material will be needed.

Graded areas that will be used by heavy equipment should have a slope less than or equal to 3:1.

Installation Considerations

Grading should not occur during rain events.

The surface should be scarified to a minimum depth of 8 cm before placing topsoil.

If areas become extremely compacted through grading, the surface should be ripped/subsoiled to help facilitate drainage and vegetative root growth that would otherwise be inhibited by compacted soil.

Once final grading is complete, areas must be fully stabilized.

Erosion Control and Considerations

The use of buffer zones around adjacent areas can be used to as an erosion control measure.

Slope breaks can be used to reduce the length of a cut or fill slope, limit sheet and rill erosion and prevent gullying. Table 1 provides a spacing guide[1]:

	Slope*	Slope Break Spacing (m)
Steep Slopes	2:1 (50%)	6.0
	3:1 (33%)	11.0
	4:1 (25%)	14.0
Long Slopes	15-25%	15.0
	10-15%	24.0
	6-10%	38.0
	3-6%	61.0
*100% slope = 1:1 = 45°	<3%	91.0

[1] British Columbia Ministry of Energy and Mines, 2002.

Post-grading, areas must be stabilized immediately. This is accomplished through hydro-seeding, vegetation, riprap installation, etc. If final grading is delayed, use mulch for temporary stabilization.

Surfaces can be roughed to help prevent erosion by increasing water infiltration.

To avoid water flowing on newly graded slopes, creating the potential for sedimentation and erosion, all runoff should be diverted to an appropriate outlet.

Maintenance

Graded areas should be checked immediately after heavy rainfalls. If sediment has accumulated in areas, it should be removed. If areas have been washed out, they should be repaired immediately.

Channels and diversions should be cleared of sediment until vegetation has had time to establish.

Sources

British Columbia Ministry of Energy and Mines. 2002. Aggregate Operators Best Management Practices Handbook for British Columbia. Volume II: Best Management Practices.

Metropolitan Council/Barr Engineering Co. 2009. Minnesota Urban Small Sites BMP Manual. Construction Practices: Grading. <http://www.metrocouncil.org/environment/Water/BMP/CH3_RPPConstGrading.pdf>, June 2010.

Alberta
Sustainable Resource Development

Grass Lined Channels

Purpose

Vegetation linings are used in channels along roadways or around the property perimeter. They are generally constructed, using native vegetation, for the purpose of handling concentrated surface runoff along moderate slopes to prevent erosion and sedimentation by lowering water velocity and binding sediment. Grass-lined channels can be used where:

- Surface runoff is causing erosion within a channel;
- Channel grades are less than 5%; and
- Space is available for a fairly wide and shallow cross section.

Grass-line Channels are not appropriate for natural waterways. Natural waterway should not be channelized unless approvals are obtained.

Grassed channels usually are not typically designed to solely control high flows. They are often used in combination with other BMPs, such as riprap stabilization. They should not be used in areas where flow rates exceed 1.5 metres per second.

Design Considerations

Grass-lined channels should be designed early in the construction schedule, prior to grading and paving as these activities will increase surface runoff.

The channel should be built according to the planned alignment, grade and cross section.

Channels should be designed to convey runoff from a 10-year storm without erosion.

The cross section can be V-shaped, trapezoidal or parabolic depending on the need and site condition.

The cross-section should be wide and shallow with relatively flat side slopes so that water can flow over the slopes without creating erosion.

The sides of the channel should be sloped less than 2:1, and triangular-shaped channels along roads should be sloped 2:1 or less for safety.

Channels should be designed to accommodate 110% of peak/storm flows and account for the vegetation planted in the channel.

Erosion and Sediment Control

Rip-rap, linings or sod may be required at concentrated inflows, corners and outfalls to protect the channel banks.

Seed the channel immediately after grading and protect with erosion control blankets, mulch or other geo-textiles.

Channels should drain into stable treatment structures such as sediment basins or sediment traps. They should not drain into natural waterways and should be designed so that fish are unable to enter the channel.

Maintenance

Grass-lines channel should be inspected and repaired as required after storm events during initial establishment.

Channels should be regularly checked for debris, scour or erosion and immediately repaired.

Outlets and road crossings should be inspected for bank stability and drop scour. Repairs should be made immediately.

Remove sediment and debris from channel as needed to prevent blockage and maintain functionality.

Additional Considerations

If installed improperly grass-lined channels can later natural flow of surface water across a site.

If channel is not properly designed to handle large storm events then the vegetation within the channel may not be enough to prevent erosion resulting in the destruction of the constructed channel.

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Rock Outlets

Purpose

A rock outlet is a protective device that is designed to control erosion at the downstream end of a channel or culvert. It is composed of rock, riprap, or concrete rubble and is placed at the outlet/downstream end. By reducing velocity of water flowing through the end of the channel, the rock outlet helps to decrease scour and downstream erosion.

It is appropriate in areas where discharge velocity has the potential to cause erosion and where flow is already sediment laden.

Source: Livestock and Land, 2010

Figure 1: A rock outlet can provide erosion control at the downstream end of a culvert or a channel.

Design Considerations

Rock outlets should be designed by a registered professional and plans/specs must be used throughout the construction. The following are minimum design requirements[1]:

- Grading: the elevation of the downstream end of the rock outlet should be the same as the elevation of the bottom end of the receiving channel.
- Alignment: the rock outlet should be straight. If curves are needed, they should be located at the upstream end.
- Riprap: the riprap should be well-graded and comprised of rocks of various sizes. Ideally, large rock will dominated and smaller rocks will be used to fill in spaces.
- Riprap thickness: minimum thickness should be 1.5 times the maximum rock diameter.
- Riprap length: rock outlets should be as long as necessary to minimize erosion in the receiving environment.
- Rock quality: field stone or quarry stone should be used. It should be hard, angular and chemical and weather resistant. The filter can be a geotextile fabric or a later of sand/gravel, or both.
- Toewalls: these should be constructed according to the design. They may help to prevent maintenance problems if installed around the entire perimeter.

[1] City of Springfield Department of Public Works Storm Water Services Division. 2008.

General Installation Procedure

- Clear the area of trees, brush, etc. that may interfere with construction. Excavate the area below the design elevation to allow for the height of the filter and riprap. Compact the foundation to the appropriate density
- Geotextile filters: place material on the foundation. If necessary, overlap the upstream piece on the downstream piece (not vice versa) by 1.5 ft in all directions. If material tears, place a new piece over top overlapping 1.5 ft. Staple the new piece in place.
- Sand/gravel filters: ensure that the material is clean. There must be enough fine material to prevent the larger material to move through the filter layer. The filter layer should be uniform in thickness. Gradation and compaction should follow design specifications.
- Riprap: install riprap according to design specifications. In the case of undefined channels, ensure that the cross sections are level or slightly lower in the middle. The top of the riprap should be level with or slightly below the receiving watercourse.
- Erosion control: disturbed areas must be stabilized immediately after installation.
- Construction verification: ensure that all design specifications were met.

Maintenance

Inspection is required after storm and runoff events, and repair should be done as soon as possible. Ensure that added stones/rocks are not placed above the finished grade.

Additional Considerations

Avoid using grouted riprap because freezing and thawing of the riprap will result in the grout breaking up. Large storms have the potential to wash away rocks. Durable and angular rocks yield best results.

If there are any circumstances that will result in design specifications not being met, consult the designer. It is important to follow design specifications because deviations (e.g., foundation not excavated deep enough, riprap too small) can result in erosion, scouring, etc.

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Sediment Basin / Settling Pond

Purpose

Sediment basins, or retention basins, are temporary sedimentation control measures (Figure 1). They are ponds that can be used to temporarily hold stormwater or water used during mining/construction, thereby allowing sediment to filter out. They can be used for a drainage area of 2 to 40 ha in size, and are effective for up to 18 months.

Figure 1: Temporary sediment basin designed to hold storm water or water used during construction.

Design Considerations

Identify all water sources that will be directed into the sediment basin(s) to ensure that the design parameters are appropriate. Consider whether the sediment pond will be dredged and re-used or filled in and closed once it is no longer needed for its initial purpose. This may affect the amount of land required.

Location of sediment basins to natural waterbodies should be considered to minimize the effect of potential settling pond flooding, berm failure, and other releases during high runoff or stormwater events.

Sediment basins should be constructed at the site's natural outlet or an area where water from the site naturally collects. This location will ideally be where the largest amount of runoff will be intercepted, and where a post-construction detention basin is proposed. Sediment basins should not be erected in a natural or undisturbed waterbody or watercourse.

Diversion dykes can be used to direct drainage into the basin. The length of the flow path leading to the pond(s) should be 3 – 5 times the width of the pond.

The basin capacity should be approximately 50 m3 per hectare of drainage area, or roughly 40% of the height x surface area. There are formulae available to calculate the ideal size of the sediment basin. However, they are beyond the scope of this BMP manual; please refer to McCullah (1993).

Sediment basins are only 70 – 80 % effective, and detention time must be 24 – 40 hr to allow for removing sediment as small as medium size silt. For removal of smaller sediment, retention time should be longer. It may be difficult to build a sediment pond large enough to hold water for a sufficient length of time; therefore, it can be beneficial to implement additional erosion and sedimentation control measures. This can include minimizing disturbance, temporary seeding, mulching, diversion dykes, etc. These control methods will help reduce sediment before it enters the basin.

Additionally, multiple ponds can be constructed in a series. The first pond will allow for filtering out the coarsest material, while the final pond will filter out the finest material. Because not all ponds are used at the same time, maintenance can occur at one or two ponds while the others are being used. If possible, the system should be designed in a closed loop layout to support water conservation initiatives and allow for on-site process water management.

Soil characteristics, land availability and overall cost must be considered when developing a sediment basin.

Installation Considerations

To prepare the site, remove all topsoil and vegetation from the area. Compact the area if needed.

The embankment must be clear of vegetation, roots, stones, rocks, etc. Construct the embankment with mineral soil containing enough moisture to form into a ball by hand without crumbling. You should not be able to squeeze water out of the ball. This material should be added in 0.2 m lifts, over the entire length. Compact the fill by using a compactor or by driving over it with at least one wheel or tread track of the equipment. Due to the settling potential, the embankment should be constructed at an elevation of 10% higher than the design. This can be decreased to 5% if a compactor is used.

The standpipe riser can be perforated plastic pipes, screened, or T-intersections.

The spillway should be place on a smooth, firm soil foundation, not over unprotected mineral soil. All connections between risers and riser bases must be watertight. Fill material around the spillway should be in 10.2 cm thick layers and compacted to the same density as the embankment. Proper design elevations, widths, and entrance and exit channel slops are essential for proper functioning of the spillway.

Ideally, the area (embankment, spillway) will be stabilized with temporary vegetation immediately following basin construction, but must be done within 2 weeks.

Maintenance

Sediment basins must be maintained. Prior to a rain event, the water level should be drawn down if necessary. Once the basin is 1/3 full of sediment, it must be cleaned out. Ensure that outlets are free of debris, rocks, etc. that have the potential to block water.

Once the sediment basin is no longer needed, the structure should be levelled or removed according to the erosion and sedimentation control plan.

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Appendix C

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